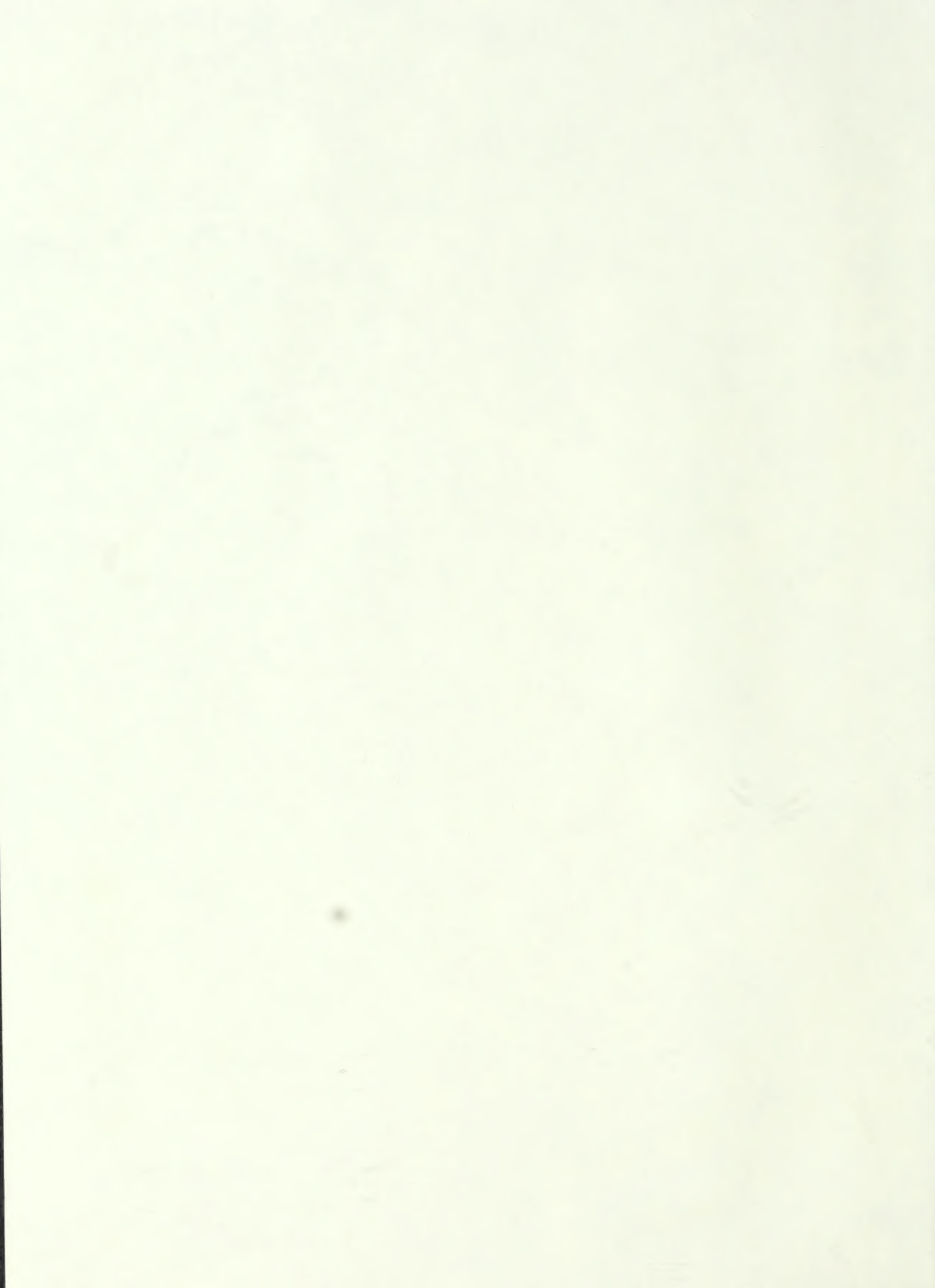




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Northeastern
Station

General
Technical
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1985



Publications of the Northeastern Forest Experiment Station - 1983



Publications

Availability of Publications

Most Station publications (Research Papers, Notes, General Technical Reports, and Resource Bulletins) are available from Station headquarters in Broomall, PA. For copies of articles not published by the Station, contact a university library or the Northeastern Forest Experiment Station author or co-author. A list of Station authors by location follows the citations. Full mailing addresses for headquarters and field locations are located on the inside back cover.

Adams, Edward L. **Use of recording watt/varmeter to evaluate the electrical power requirements of a combination edger.** Gen. Tech. Rep. NE-79. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 5 p.

The data provided by a recording watt/varmeter have many uses. We measured power consumed by a combination edger processing red oak material—cants gang-sawed on one side of the edger and boards edged on the other. Log sizes processed through the headrig and sizes of material processed through the edger were also recorded.

Anderson, Christine B.; Fosbroke, David E.; Frank, Robert M.; O'Keefe, Timothy G. **The spruce budworm and you: How to recognize damage and minimize losses.** Orono, ME: University of Maine and USDA Forest Service; 1983. 20 p.

A companion volume to an audio visual presentation.

Anderson, R. Bruce. **Furniture rough mill costs evaluated by computer simulation.** Res. Pap. NE-518. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

A crosscut-first furniture rough mill was simulated to evaluate processing and raw material costs on an individual part basis. Distributions representing the real-world characteristics of lumber, equipment feed speeds, and processing requirements are programed into the simulation. Costs of parts from a specific cutting bill are given, and effects of lumber input costs are discussed. GASP IV (A Combined Continuous/Discrete FORTRAN-based Simulation Language) was used.

Andreadis, T. G.; Dubois, N. R.; Weseloh, R. M.; Moore, R. E. B.; Anderson, J. F.; Lewis, F. B. **Aerial spray tests with *Bacillus thuringiensis* for control of the gypsy moth in Connecticut.** New Haven, CT: Connecticut Agricultural Experiment Station; 1982; Bull. 807. 5 p.

Two experimental strains of *Bacillus thuringiensis* Berliner, HD-243 and HD-263, and the commercial strain, HD-1, were evaluated against natural infestations of *Lymantria dispar* (L.) in aerial spray trials. Two weekly applications of HD-1 at 8 BIU/0.4 ha, or a dry weight equivalent for the experimental strains, gave significant reductions in larval density and good foliage protection. HD-243 and HD-263, which previously had been identified as more potent against gypsy moth larvae in laboratory bioassays, were as effective but no better than HD-1 in the field. One application of HD-1 also was effective in reducing larval populations and

protecting foliage but did not protect foliage as well as two applications of the same strain.

Andreadis, Theodore G.; Dubois, Norman R.; Moore, Robert E. B.; Anderson, John F.; Lewis, Franklin B. **Single applications of high concentrations of *Bacillus thuringiensis* for control of gypsy moth (*Lepidoptera: Lymantriidae*) populations and their impact on parasitism and disease.** Journal of Economic Entomology. 76(6): 1417-1422; 1982.

In aerial spray trials with *Bacillus thuringiensis* Berliner conducted against dense populations of *Lymantria dispar* (L.), single applications of 12 and 16 BIU/0.4 ha gave significant reductions in larval density and excellent foliage protection. Less than 4 percent net defoliation was observed in treated plots, compared with 69 percent in untreated plots; this level of control was equivalent to that achieved with two weekly applications at 8 BIU/0.4 ha.

Araman, Philip A. **BLANKS: A computer program for analyzing furniture rough-part needs in standard-size blanks.** Res. Pap. NE-521. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.

Describes a computer program that allows a company to determine the number of edge-glued, standard-size blanks required to satisfy its rough-part needs for a given production period. Yield and cost information also is determined by the program. A list of the program inputs, outputs, and uses of outputs is described, and an example analysis with sample output is included.

Araman, Philip A. **Program BLANKS analyzes rough-part needs in standard-size blanks.** NE-INF-44-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 6 p.

Describes a computer program that will allow a company to determine the number of edge-glued standard-size blanks required to satisfy their rough-part needs for a production period. Yield and cost information are also determined by the program. Lists program inputs, outputs, and uses of outputs. Includes an example analysis with sample output.

Araman, Philip A. **Standard-size blanks for furniture and cabinets.** NE-INF-45-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.

Discusses what standard-size blanks are, why standard sizes are used, who can use them, and how they can be made.

Araman, Philip A.; Hansen, Bruce G. **Conventional processing of standard-size edge-glued blanks for furniture and cabinet parts: a feasibility study.** Res. Pap. NE-524. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

Each year the manufacturers of furniture and cabinets use over 2 billion board feet of hardwood lumber. As demand intensifies, we will need to utilize more of the abundant lower grade hardwood resource to assure future supplies at reasonable prices. Conventional processing of standard-size hardwood blanks manufactured from log-run red oak lumber, a resource containing over 40-percent low-grade No. 2 Common lumber, has been shown to be technically and economically feasible. Internal rates of return from 26 to 40 percent are possi-

ble when blanks are produced for outside sales or replace open-market purchases of dimension.

Araman, Philip A.; Hansen, Bruce G. **The dollars and cents of conventional processing of standard-size blanks.** NE-INF-43-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.

A modern conventional processing system, the raw material inputs, and product outputs and yields are presented. The economics are presented to show the product costs to potential producers who wish to use blanks internally and the investment potential to potential producers who wish to sell blanks.

Araman, Philip A.; Reynolds, Hugh W. **Crafts offer new market for edge-glued panels.** Wood & Wood Products. 88(6): 86, 88, 90; 1983.

To find out if craftsmen would be interested in purchasing edge-glued standard-size panels as a supplement to or substitute for hardwood lumber and hardwood plywood, we went to two trade shows and asked them. The results, which were positive, are presented in this report along with some possible steps for the development of this new market opportunity by dimension manufacturers.

Araman, Philip A.; Reynolds, Hugh W. **Craftsmen say "we want edge-glued, standard-size panels."** Res. Note NE-312. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p.

Wood craftsmen would like an alternative to hardwood lumber and plywood and softwood products. They are very interested in edge-glued, standard-size panels. These conclusions are based on interviews with craftsmen at two trade shows, and the results are included in this report along with our recommendations for optimum acceptance by craftsmen of this new product.

Ashby, W. Clark; Vogel, Willis G.; Kolar, Clay A. **Use of nitrogen-fixing trees and shrubs in reclamation.** In: Pope, P. E., ed. Proceedings 3rd annual better reclamation with trees conference; 1983 June 2-3; Terre Haute, IN. West Lafayette, IN: Purdue University, Department of Forestry and Natural Resources; 1983: 110-118.

Auchmoody, L. R. **Using fertilizers to regenerate Allegheny hardwoods.** In: Finley, J.; Cochran, R. S.; Grace, J. R., eds. **Regenerating hardwood stands: Proceedings of a symposium**; 1983 March 15-16; University Park, PA. University Park, PA; Pennsylvania State University; 1983: 160-170.

Establishing vigorous natural regeneration of desirable species after harvest cutting of Allegheny hardwoods is difficult in northwestern Pennsylvania. Seedling growth rates are limited by a combination of heavy deer browsing and severe nitrogen and phosphorus deficiencies in the soil after overstory removal. Research during the past 10 years has shown that forest fertilization can stimulate seedlings and developing regeneration to grow above the reach of deer within one or two seasons.

Baker, C. Jacyn; Melhuish, John H., Jr. **Effect of divalent cations on germination of urediospores of *Uromyces phaseoli*.** Phytopathology. 73(6): 964; 1983. Abstract.

Barger, J. H. **European elm bark beetle catches on mul-ture-baited sticky traps increased by spraying the trap standards with methoxychlor.** In: Hall, Franklin R., compiler. Proceedings, 38th annual meeting, North Central Branch of Entomological Society of America; 1983 March 15-17; St. Louis, MO.

Wooster, OH: North Central Branch of Entomological Society of America; 1983. Abstract 55.

In earlier studies, where healthy elms were used, methoxychlor insecticide was sprayed on the boles of some elms to determine if protection against non-captured beetles was needed. Results showed that traps on sprayed elms captured more than twice as many beetles as traps on unsprayed elms. Thus, a study was conducted to determine if this phenomenon was restricted to healthy elms only, if similar results could be obtained on a variety of other standards, and if the type of trap standard affected beetle catches.

Barnard, Joseph E. **Accomplishments and plans in the North.** In: A National Review of Forest Inventory and Analysis Research in the USDA Forest Service; 1983 November 15-16; Washington, DC. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 20-22.

The Forest Inventory and Analysis units of the North Central and Northeastern Forest Experiment Stations have conducted a program of forest inventory in 25 states for nearly four decades. There have been significant past accomplishments in research, inventory, and analysis. Today the program of forest inventory being carried out in the North is multiresource in scope. Future goals relate to the expanded use of this information in state and regional policy and program implementation and continued economic development of the 180 million-acre forest resource.

Barnard, Joseph. **Maine's hardwood resource.** In: Proceedings, hardwood forest management and utilization symposium; 1982 October 25-26; Orono, ME. Misc. Rep. 279. Orono, ME: University of Maine, Maine Agricultural Experiment Station; 1983: 4-5.

Discusses the third inventory of Maine completed in July 1982. Presents some preliminary results available for 12 million of the 17 million acres of forest land in Maine.

Beckjord, Peter R.; Melhuish, John H., Jr.; McIntosh, Marla S.; Haeskeylo, Edward. **Effects of nitrogen fertilization on growth and ectomycorrhizal formation of *Quercus alba*, *Q. rubra*, *Q. falcata*, and *Q. falcata* var. *pagodifolia*.** Canadian Journal of Botany. 61(10): 2507-2514; 1983.

Oak seedlings were grown for 105 or 110 days in containers in a greenhouse in a medium with and without vegetative or basidiospore inoculum of the ectomycorrhizal fungi *Pisolithus tinctorius* and *Scleroderma aur-anteum*. At 15 days after planting acorns, nitrogen in the form of sodium nitrate or ammonium chloride was added to each container at the rates of 0.0 or 100 mg nitrogen per seedling. Growth of all seedlings that were not fertilized was significantly less than seedlings fertilized with nitrate or ammonium nitrogen (100 mg N). Ectomycorrhizal development of all seedlings that were not fertilized or fertilized with sodium nitrate (100 mg N) was significantly less than seedlings fertilized with ammonium chloride (100 mg N). Ectomycorrhizal development of oak species varied with different mycorrhizal inocula.

enoit, L. F.; Skelly, J. M.; Moore, L. D.; Dochinger, L. S. **The influence of ozone on *Pinus strobus* L. pollen germination.** Canadian Journal of Forest Research. 13(1): 184-187; 1983.

Along the Blue Ridge Parkway in Virginia, branchlets and pollen were collected from native eastern white pine trees that were sensitive, intermediate, and tolerant to oxidant air pollution based on foliar symptom expression. Fumigation of branchlets with 0.10 ppm ozone (O_3) for 4 or 8 hours per day until anthesis did not affect pollen production or germinability. However, the percent germination was significantly ($P \leq .01$) reduced in pollen exposed under wet conditions to 0.15 (O_3) for 4 hours. The importance of this finding in the reproduction of pines is discussed.

Kenzie, John W.; Smith, Thomas M.; Frank, Robert M. **Balsam fir.** In: Silvicultural systems for the major forest types of the United States. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 102-104.

Kerry, Frederick H.; Mielke, Manfred E. **How to reduce decay in high-value hardwood trees.** NE-INF-46-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 6 p.

Discusses the decay process, how decay enters trees, and how to control decay.

Killer, Cleveland J. **Whole-tree harvesting with a medium capacity cable yarder.** In: Proceedings, 1982 winter meeting American Society of Agricultural Engineers; 1982 December 14-17; Chicago, IL. Paper No. 82-1591. St. Joseph MI: American Society of Agricultural Engineers; 1983. 16 p.

A time study was conducted to monitor productive and nonproductive times during logging with a medium-capacity cable yarder harvesting whole hardwood trees in a clearcut. Prediction equations were developed to estimate the cycle time for the yarder, and yarding cost was calculated at \$3.33 m^3 (\$7.33/cord @ 78 m^3 /cord) for whole-tree chips.

Killer, Cleveland J.; Peters, Penn A. **Harvesting whole-tree Appalachian hardwoods with a Washington 78 yarder.** In: Proceedings, 1983 winter meeting American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. St. Joseph, MI: American Society of Agricultural Engineers; 1983: Paper No. 83-1605.

Time studies were conducted on a Washington Iron Works Skylok 78 cable yarder to develop regression equations to estimate production and cost of yarding whole trees in Appalachian hardwoods.

Kirch, Thomas W. **The forest-land owners of New York.** Resour. Bull. NE-78. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 80 p.

A statistical analytical report on a mail canvass of private commercial forest-land owners in New York. The study was conducted in conjunction with the third forest survey of New York by the USDA Forest Service. It discusses landowner characteristics, attitudes, and intentions of owners regarding reasons for owning, recreational use, timber management, and harvesting.

Kirch, Thomas W. **Northeastern woodland ownership study—the second time around.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 62-65.

How does one select attributes to measure change in the ownership patterns and attitudes of the forest-land owners in the 14 northeastern states? Such important variables as form of ownership; nature of business; owner's occupation, age, education, income, and residence; size class of ownership; number of tracts; past harvesting practices and intention to harvest; and reason for owning forest land are discussed. How this trend information can be used by policymakers to evaluate programs and by forest industry to forecast timber availability will be demonstrated.

Kirch, Thomas W. **Private forest-land owners in the United States: Their numbers and characteristics.** In: Royer, Jack P.; Risbrudt, Christopher D., eds. Nonindustrial private forests: A review of economic and policy studies: Proceedings of a symposium; 1983 April 19-20; Durham, NC. Durham, NC: Duke University; 1983: 71-75.

A 1978 survey estimates that 7.8 million ownership units hold 333 million acres of privately owned forest land in the United States. Nearly half of the forest land is in ownerships greater than 500 acres and is owned by less than 1 percent of the ownership units. By occupation group, farmers own 16 percent of the forest land, retired people own 14 percent, white collar people own 15 percent, blue collar and other individuals own 21 percent, and the remaining 34 percent of the forest land is owned by corporations, large partnerships, and estates. Such important variables as owner age, residence, and education are discussed.

Kirch, Thomas W. **Who's woods are these?—7.8 million private forest-land owners.** Crossties 64(3): 13-14, 16, 18; 1983.

A 1978 survey estimates that 7.8 million private ownerships own 333 million acres of forest land in the United States. Of these ownerships, 88 percent are either sole proprietors or family ownerships (husbands and wives), and they hold 55 percent of the forest land. Corporations own 27 percent of the forest land and forest industries have a major portion of that. Other information about the owners' occupation, age, residence, and education is discussed.

Blanchard, Robert O.; Shortle, Walter C.; Davis, Weston. **Mechanism relating cambial electrical resistance to periodic growth rate of balsam fir.** Canadian Journal of Forest Research. 13(3): 472-480; 1983.

Cambial electrical resistance (CER) and periodic growth rate (PGR) of canopy balsam fir trees were determined on 26 sites in Maine, New Hampshire, and Vermont, varying in level of spruce budworm defoliation. Determinations of water and potassium concentrations were made of the bark, wood, and vascular cambial zone (VCZ). Low CER was associated with high PGR and vice versa.

Blum, Barton M.; Benzie, John W.; Merski, Edward. **Eastern Spruce-fir type.** In: Silvicultural systems for the major forest types of the United States. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 128-130.

Blum, Barton M.; Klaiber, Harold M.; Randall, Arthur G. **Epinette-Sapin du Nord-Est.** In: Les choix de sylviculture dans les forêts de L'est Canadien. Fredericton, NB: Le Service de Consultation Forestière; Ministère des Ressources Naturelles du Nouveau-Brunswick; 1983: 13-19.

French translation of "Northeastern spruce-fir" in Choices in Silviculture for American Forests; Washington, DC: Society of American Foresters; 1981.

Blyth, James E.; Widmann, Richard H. **Pulpwood production in the Northeastern and Central States in 1981.** Northern Logger. 31(9): 10-11; 1983. Summarizes pulpwood production in the Northeastern and North Central States. In 1981, pulpwood production for the combined area was down 2 percent from 1980.

Bones, James T.; Wharton, Eric H. **Monitoring the changing timberland base in the Eastern United States.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 58-61.

Forest-land area in the Eastern United States has been increasing in recent years, but a significant portion of that total gain has been offset by forest-land clearing. Successive statewide forest inventories verify the trend to increased timber recovery and use. Matching timber from cleared areas with local timber markets often presents a challenge to utilization and marketing foresters. Recent wood product developments and the energy crisis have provided ready markets for material that would have been buried or burned in the past.

Bonyai, Susan A.; Sendak, Paul E. **Vermont's timber economy: a review of the statistics.** Montpelier, VT: Vermont Agency of Environmental Conservation, Department of Forests, Parks, and Recreation; 1982. 27 p.

Summarizes the most current information available on the forests of Vermont and the State's timber-based industries. Timber contributed a total of \$505 million to Vermont's economy in 1980.

Born, David J.; Barnard, Joseph E. **FINSYS-2: Subsystem TABLE-2 and OUTPUT-2.** Gen. Tech. Rep. NE-84. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 133 p.

Describes a computer software package for use in developing statistical tables from a resource inventory data set. The flexibility of the system in performing user-designated table-making functions also is described. Full instructions for operating the system are included.

Brann, Thomas B.; Reams, Gregory A.; Solomon, Dale S. **Spruce budworm growth impact study, 1981 report.**

Orono, ME: University of Maine; 1983; Misc. Rep. 287. 73 p.

The Maine Spruce Budworm Growth Impact Study was initiated in 1975 as a cooperative effort among the CANUSA program; USDA Forest Service, Northeastern Area State and Private Forestry; and 11 private forestry companies to document the impact of the spruce budworm, on the growth and mortality of the Maine forest.

Brisbin, Robert L.; Rast, Everette D. **Predicting hardwood tree quality.** In: America's hardwood forests-opportunities unlimited: Proceedings, 1982 convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American Foresters; 1983: 118-120.

Evaluating hardwood tree quality has become more important in the recent past because of relatively high raw material costs, increased awareness of the variability in tree quality, and a desire to utilize timber for the best use. Hardwood tree grades for predicting factory lumber yields have been developed and are being used by several organizations. Research is in progress on quality classification in young stands to investigate the effects of cultural treatments and management techniques on quality development.

Brooks, Robert T. **Vermont's first forest-wildlife habitat assessment.** Montpelier, VT: Vermont Fish & Game Department, Habitat Highlights. 3(3): 4; 1983.

The Forest Inventory and Analysis unit of the Northeastern Forest Experiment Station, USDA Forest Service, in cooperation with the Department of Forests, Parks, and Recreation of the Vermont Agency of Environmental Conservation, is conducting an inventory of Vermont's forest resources. This inventory will include an assessment of forest wildlife habitat.

Brooks, Robert T.; Porter, William F. **Development of a procedure to establish conditions and monitor changes in regional wildlife habitat quality.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 223-226.

Presents a procedure, built on established, recurring land use and natural resource inventory data, for a national wildlife habitat assessment program. Multivariate statistical methods are used to analyze land cover and wildlife abundance relationships. Established regional relationships between abundance levels of key wildlife species and concurrent land cover conditions can be used to predict the effects of landscape change on habitat quality and wildlife abundance. Preliminary efforts have identified deficiencies in both the data and procedure design. These issues must be recognized, and resolved if possible, before this procedure can be applied to national wildlife habitat evaluation programs.

Brooks, Robert T.; Scott, Charles T. **Quantifying land-use edge from aerial photographs.** Wildlife Society Bulletin. 11(4): 389-391; 1983.

Land use interspersed with its resultant edge is important to many wildlife species' habitat. Land use

edge is most conveniently evaluated on aerial photographs. A cross-hatch and radial-line transect pattern are compared for estimating edge length: the cross-hatch pattern used as part of a double sampling procedure is recommended. Formulas for estimating total edge length and its variance are provided.

Brush, Robert O. **Managing for scenery on private woodlands.** In: Proceedings, 2nd national urban forestry conference; 1982 October 10-14; Cincinnati, OH. Washington, DC: American Forestry Association; 1983: 360. Poster session abstract.

Butler, David A.; LeDoux, Chris B. **Reference manual for THIN: A cable yarding simulation model.** Corvallis, OR: Forest Research Laboratory, Oregon State University; 1983. 35 p.

A computer simulation model called THIN was developed that can evaluate two cable yarding methods: single-state and prebunch-and-swing. The reference manual explains input, execution, output, and evaluation of the simulation. Input variables are data of actual timber stand details: log location, volume, area, terrain, labor, equipment, and yarding method. Output results include the volume and rate of logs harvested by either yarding method. Thus, several costs of cable logging may be estimated. THIN is programmed in FORTRAN IV, uses subroutines of GASP IV, and is fully operational.

Cain, M. D.; Yaussy, D. A. **Reinvasion of hardwoods following eradication in an uneven-aged pine stand.** Res. Pap. SO-188. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1983. 8 p.

Annual application of mechanical and chemical treatments for 12 years only temporarily eradicated hardwood species from an uneven-aged loblolly/shortleaf pine stand in south Arkansas. Eighteen years after treatments ended, an abundance of woody shrubs and hardwood trees had reinvaded the stand and denoted an early stage in successional development from pine to hardwood when compared to four other stands managed at various intensity levels.

Cannon, W. N., Jr. **Effects of density and temperature on gallery construction and oviposition of *Scolytus multistriatus*.** In: Hall, Franklin R., compiler. Proceedings, 38th annual meeting, North Central Branch of Entomological Society of America; 1983 March 15-17; St. Louis, MO. Wooster, OH: North Central Branch of Entomological Society of America; 1983. Abstract 56.

Presents results of studies on the interactions of temperature and adult density on gallery construction and egg production by female European elm bark beetles.

Cannon, William N., Jr.; DeBald, Paul S.; Worley, David P. **Survival of elms—a guide to Dutch elm disease control performance.** In: Urban and suburban trees: Pest problems, needs, prospects, and solutions; 1982 April 18-20; East Lansing, MI. East Lansing, MI: Michigan State University; 1982: 36-41.

Communities experiencing or facing Dutch elm disease (DED) have the problem of saving as many elms as possible

as long as possible as efficiently as possible. These are linked together by the elm survival rate. Like most real-world problems, the DED problem is transitory; efforts to solve it need to be explicitly and narrowly stated in order to: (1) design relevant research (a scheme to do this is presented), (2) test research results against relevant standards, and (3) communicate research findings in such a form that they can be acted upon. Defining the problem in terms of elm survival rate allows researchers to do this. Since community officials are concerned with saving elms, we have a common means of communication.

Carey, Andrew B. **Cavities in trees in hardwood forests.** In: Snag habitat management: Proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. Gen. Tech. Rep. RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1983: 167-184.

Describes the variety and abundance of cavities in second-growth hardwood forests in West Virginia, and provides managers with a better understanding of the cavity resource.

Carey, Andrew B. **Monitoring diurnal, cavity-using bird populations.** In: Snag habitat management: Proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. Gen. Tech. Rep. RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1983: 188-199.

Addresses some limited aspects of the monitoring requirements now being addressed by the National Forest System; deals with monitoring populations of cavity-using birds in upland deciduous forests in Appalachia.

Carey, Andrew B.; Gill, John D. **Direct habitat improvements—some recent advances.** In: Snag habitat management: Proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. Gen. Tech. Rep. RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1983: 80-87.

Den boxes can be made smaller, more accessible, and more resistant to predators by adding an inside shelf just below the entrance. Boxes placed on the lee sides of trees were preferred by squirrels in winter but not in spring or summer. And den boxes can raise the carrying capacity of young forest for sciurids. Using a chain saw to create tree cavities to be covered with a wooden faceplate is more efficient than routing dens with a drill or creating dens with a chain saw and chisel. Small woodpeckers will excavate cavities in styrofoam cylinders. These "plastic trees" offer some intriguing management and research applications.

Carl, Clayton M., Jr. **Nursery practices.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 47-52.

Summarizes information that will help growers produce plantable sugar maple seedlings.

Carl, Clayton M., Jr. **Seed collection and handling.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 42-46.

Discusses information on sugar maple seed development and on the proper methods of collecting and handling the seeds.

Carl, Clayton M., Jr. **Stratification of sugar maple seeds.** Tree Planters' Notes. 34(1): 25-27; 1983.

Sugar maple seeds collected from 10 trees in northwestern Vermont were stratified at 10 to 30°C for up to 13 weeks. Results indicate that this method is unsatisfactory for obtaining rapid, maximum germination after stratification.

Carroll, J. E.; Tattar, T. A.; Wargo, P. M. **Relationship of root starch to decline of sugar maple.** Plant Disease. 67(12): 1347-1349; 1983.

Starch content of roots of streetside sugar maples (*Acer saccharum*) was scored visually on the basis of intensity of staining of xylem sections treated with I₂-KI. A significant relationship occurred between root starch content in autumn and decline symptoms: trees with declining crowns had the least starch. More trees with low or depleted starch supplies decline in crown condition than trees with moderate or high starch. This technique, used as an indicator of tree health, may be useful for detecting early stages of decline.

Cech, Franklin C.; Keys, Roy N.; Davidson, Walter H. **Establishment and early growth of sweetgum planted on disturbed land.** In: Pope, P. E., ed. Proceedings, 3rd annual better reclamation with trees conference; 1983 June 2-3; Terre Haute, IN. West Lafayette, IN: Purdue University, Department of Forestry and Natural Resources; 1983: 217-228.

Charlton, Philip M. **Utilization of taper systems for estimating total-tree height of Appalachian hardwood species.** Morgantown, WV: West Virginia University, Agricultural and Forestry Experiment Station; West Virginia Forest Notes Circular. 123(10): 3-6; 1983.

Evaluates four taper equations to estimate total-tree height and to determine predictive potential for Appalachian hardwoods of northern West Virginia.

Choudhury, B. J.; Federer, C. A. **Simulating spatial and temporal variation of corn canopy temperature during an irrigation cycle.** Greenbelt, MD: National Aeronautics and Space Administration, Goddard Space Flight Center; 1983; NASA Tech. Memo 84991. 36 p.

The canopy-air temperature difference may provide an index for scheduling irrigation. Combining the Monteith transpiration equation with both uptake from a single-layered root zone and change in internal storage of the plant, we have explicitly solved the continuity equation for water flux in the soil-plant-atmosphere system.

Considine, Thomas, Jr. **Wildlife needs private forest land management.** Pennsylvania Game News. 54(3): 14-17; 1983.

More than 230 birds and mammals depend on Pennsylvania's 16 million acres of forest. Wildlife populations are generally in good shape, but two forest trends observed in the latest forest survey could influence future population levels. Declining proportions of oak in the timber inventory and increasing areas of sawtimber sized stands are trends likely to continue. Increasing loss of an important food source and habitat diversity are likely results of these trends. Private nonindustrial landowners own the largest amount of forest land and need to get involved in forest management to help future wildlife populations.

Considine, Thomas, Jr.; Barnard, Joseph E. **Current structure and composition of Pennsylvania's forest lands as it relates to future regeneration.** In: Proceedings, Regenerating hardwood stands; 1983 March 15-16; University Park, PA. University Park, PA: The Pennsylvania State University; 1983: 30-36.

Pennsylvania has an abundant and valuable forest resource. Concerns have arisen about the future species composition of Pennsylvania's forests. Forest survey regeneration data are not complete, but available data suggest that changes in species composition are possible.

Corbett, Edward S. **The impact of atmospheric deposition and land use practices on water quality from municipal watersheds.** In: Proceedings, National acid precipitation assessment program; 1983 February 21-25; Raleigh, NC. Raleigh, NC: North Carolina State University; 1983: A5, 29-35.

Recent evaluations of episodic hydrologic events indicate that substantial depressions in streamflow pH can occur over a relatively short period of time. One such depression occurred during a 4.38-inch rainstorm on a forested watershed when stormflow pH dropped from 7.32 to 4.95 within a 37-hour period and the H⁺ concentration increased more than 200 times. Stream alkalinity was almost entirely depleted with only a slight recovery occurring 1 week after the storm. Current research is focusing on evaluating the impacts of episodic events on stream chemistry for a variety of stream locations.

Corbett, Edward S.; Lynch, James A. **Rapid fluctuations in streamflow pH and associated water quality parameters during a storm flow event.** In: International symposium on hydrometeorology; 1982 June 13-17; Denver, CO. Bethesda, MD: American Water Resources Association; 1983: 461-464.

Three aspects of hydrometeorological significance—the quality of precipitation, the watershed response of converting precipitation into streamflow, and the resulting change in streamflow quality—were studied on a forested experimental watershed in central Pennsylvania.

Craft, E. Paul; Whitenack, Kenneth R., Jr. **A classification system for predicting pallet part quality from hardwood cants.** Res. Pap. NE-515. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 7 p. A system for classifying cants for pallet part production was developed that more accurately predicts

the pallet parts grade mix that can be sawed from cants than the structural timber grades that are now used. A formula is given to determine value relatives for each cant class.

Cragg, Richard E.; Robinson, Susan G.; Noble, Reginald D.; Dochinger, Leon S. **Acid fog effects on yellow-poplar leaf morphology.** *Micron*. 14(1): 75-76; 1983.

To perform a controlled study of acid fog effects on leaf morphology, 1-year-old seedlings of yellow-poplar were maintained in single pass chambers covered with mylar. The plants were watered 3 times per week and kept on a 16-hour photoperiod at $90\mu\text{EM}^{-2}\text{sec}^{-1}$ and at a constant temperature of 24°C . Each chamber was equipped with a cool spray vaporizer in which deionized water was adjusted to pH levels of 5.7, 4.5, 3.5 and 2.7 by addition of appropriate amounts of $1\text{N H}_2\text{SO}_4$.

Treatment of the experimental plants was for 8 hours per day for 8 weeks.

Crawford, H. S. **Habitat management for birds that prey on spruce budworm.** *CANUSA Newsletter*. 27; 1982. Abstract.

Populations of birds that prey on spruce budworm can be improved by forest practices that increase (1) the degree of hardwood admixture with softwoods, (2) the proportion of spruce to fir, and (3) the diversity in horizontal and vertical stand structure.

Crawford, H. S.; Titterton, R. W.; Jennings, D. T.

Bird predation and spruce budworm populations.

Journal of Forestry. 81(7): 433-435, 478; 1983.

In northern New England, numbers of birds and amounts of budworm larvae and pupae eaten per bird increased as insect populations increased. Birds ate approximately 2, 23, and 87 percent of the epidemic, transitional, and endemic populations. Blackburnian and Nashville warblers, golden-crowned kinglets, white-throated sparrows, and black-capped chickadees were important predators in stands with endemic budworm populations. Bird communities most effective as budworm predators are found in mature managed forests containing a mix of species and size classes with scattered openings and patches of regeneration.

Crawford, Hewlette S.; Stutzman, Warren L. **Micro-wave attenuation as an indicator of sampling weight of herbaceous and woody plants in the field.** *Forest Science*. 29(4): 726-734; 1983.

Attenuation of microwave signals was linearly related to the weight of herbaceous plants and woody shoots ≤ 1.27 cm diameter along the transmission path in spruce-fir, northern hardwood, and mixed-wood stands. Hand-held instrumentation gave results equal to those obtained when rigid mounts were used. Signal loss was more closely related to green weight of vegetation in hardwood stands and to dry weight in softwood stands. Signal loss also was linearly related to annual growth of herbaceous and broadleaf woody vegetation.

Cuppert, Donald G. **Low-temperature drying.** *Furniture Design and Manufacturing*. 54(12): 81-83; 1982.

Experimenters found that variation in drying rates results from differences in temperature, relative humidity, and air velocity to which the lumber is exposed. Six charges were exposed to varying conditions.

Cuppert, Donald G. **Performance of a thin circular headsaw cutting hardwoods.** *Forest Products Journal*. 33(9): 33-35; 1983.

Past research indicated that 9x10 gage, 1/4-inch-kerf saw used about 15 percent less power and yielded 8 percent more product than a 7x8 gage, 9/32-inch-kerf saw cutting hardwood bolts into pallet parts. But, the experimental sawing time was too short to determine whether the thinner saw would perform equally well under sustained production. In a longer term followup study, the 9x10 gage saw performed as well as the 7x8 gage saw in processing 6- to 13-inch-diameter hardwood bolts. The thinner saw also performed satisfactorily in sawing black cherry sawlogs up to 15 inches scaling diameter, except for logs that would spring or bend substantially during the sawing.

Cuthbert, R. A.; Peacock, J. W.; Wright, S. L. **Emission characteristics of elm bark beetle aggregation attractants from controlled-release dispensers.** *Res. Pap. NE-532*. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

Release rates of the three-component aggregation attractant of the smaller European elm bark beetle from laboratory-aged and field-aged Conrel® and Hercon® dispensers were monitored for 85 days by GLC analysis of cold-trapped volatiles. Both dispensers had relatively low and constant rates of decay for all three attractant components after an initial burst in emission rates. Within limits, the ratio of components released remained constant over time and at various temperatures.

Davidson, Walter H. **Hybrid poplar sprout clumps: Thinning does not improve development.** *Journal of Forestry*. 81(10): 662-663; 1983.

One growing season after the harvest of a 16-year-old hybrid poplar plantation, sprouts from 100 clumps were thinned to retain the dominant sprout; 100 clumps were left for comparison. After three growing seasons, thinned and unthinned clumps did not differ in total number of sprouts per clump or in diameter of dominant sprouts. Dominant sprouts were significantly taller in the unthinned clumps. Thinning hybrid poplar sprout clumps after a harvest is not recommended.

Davidson, Walter H.; Vogel, Willis G. **Hybrid poplars for reclamation.** In: *Better reclamation with trees: 3rd annual conference; 1983 June 2-3; Terre Haute, IN*. Lafayette, IN: AMAX Coal Co. and Purdue University, Department of Forestry; 1983: 99-109.

Past research with hybrid poplars has shown that some clones have potential for minesoil reclamation. The most promising clones are identified. Hybrid poplars can be used for energy plantations and esthetic plantings. The wood is used for pulp, fuel, construction, lumber, furniture, veneer, boxwood, and novelty products. Research on plantation establishment and management, growth rates and timber yields, and utilization is reviewed. The report includes studies conducted in Pennsylvania, Maryland, West Virginia, Kentucky, and Ohio.

DeGraaf, Richard M.; Rudis, Deborah D. **Amphibians and reptiles of New England.** Amherst, MA: The University of Massachusetts Press; 1983. 85 p.

This publication provides the most comprehensive information available on the natural histories and habitat associations of the approximately 75 species and subspecies of amphibians and reptiles that live in forest environments of the Northeast. The information will help federal and state land management agencies, as well as private organizations, plan for the habitat needs of these important species in the management of public and private forest lands.

DeHayes, Donald H.; Hawley, Gary J.; Gregory, Robert A. **Variation in balsam fir shoot apex characteristics and shoot growth.** In: Proceedings, Third North Central Tree Improvement Conference; 1983 August 17-19; Wooster, Ohio. (Location of publisher unknown): North Central Tree Improvement Association; 1983: 53-61.

Dormant terminal buds and subsequently developed shoots were removed from several whorls of 17-year-old trees representing four balsam fir provenances and examined for variation in primordia and needle production, apical dome diameter, and the relative contributions of stem unit number and length to shoot growth.

Demeritt, M. E., Jr. **Tree improvement work in the Northeast, especially hybrid poplar.** In: Parker, Bruce L.; Hanson, Patricia M.; Teillon, H. Brenton, eds. Proceedings, 15th annual Northeastern forest insect work conference; 1982 March 11; Portland, ME. MP 108. Burlington, VT: University of Vermont Agricultural Experiment Station; 1983: 14. Abstract.

Lists species and hybrids for which genetic studies and experimental plantations have been established since 1924.

Demeritt, Maurice E., Jr. **Making the most of the hybrid poplar.** Forest Notes. 151: 2-4; Winter 1983. Growing publicity concerning the hybrid poplar trees' capacity for rapid growth in our soil and potential as a prime source of firewood warrants a review of the facts. Presented are 16 questions and answers that should present a clear picture of the hybrid poplar's place in our forests, and our economy.

Demeritt, Maurice E., Jr. **Planting and care of hybrid poplar.** NE-INF-48-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 9 p. Specifies requirements that have to be met for successful establishment of hybrid poplar: planting site requirements, site preparation, selection and storage of hybrid poplar cuttings or trees, planting of cuttings, spacing, cultivation, fertilization, and pruning.

Demeritt, Maurice E., Jr. **Six-year results of hybrid poplar clonal tests in Pennsylvania and Maryland.** In: 28th Northeastern forest tree improvement conference: Proceedings 1983; 1982 July 7-9; Durham, NH. Durham, NH: University of New Hampshire; 1983: 102-109.

Six-year height and diameter growth were measured and analyzed for 199 hybrid poplar clones at Ephrata, Pennsylvania, and Hampstead, Maryland. Six-year heights differed significantly between and within locations. Six-year diameter at breast height differed sig-

nificantly within locations. Hybrid poplar clones can be selected for use in Pennsylvania and Maryland at 6 years with predictable performance to about age 12.

Dempsey, Gilbert P.; Hansen, Bruce G.; Araman, Philip A. **Improving the export market for wood products.**

Southern Lumberman. 244(3040): 52-54; 1983. At a time when our Nation's share of international trade is dropping dramatically, our export of wood products continues to expand. Industry leaders predict that exports of U.S. wood products will continue to increase well into the future. However, numerous trade barriers limit the ability of the U.S. producers to expand exports. Before U.S. exports of wood products can achieve their true potential, research is needed to evaluate these constraints to foreign trade.

Dennis, Donald F. **An analysis of Ohio's forest resources.** Resour. Bull. NE-75. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 46 p.

A comprehensive analysis of the current status and trends of the forest resources of Ohio. Topics include forest area, timber volume, biomass, timber products, and growth and removals. Forest area, volume, and growth and removals are projected through 2009. Discusses water, soil, minerals, fish, wildlife, and recreation as they relate to forest resources. Also identified are forest management opportunities for increasing the production of major forest resources and enhancing the benefits derived from Ohio's forests.

Dennis, Donald F. **Tax incentives for reforestation in Public Law 96-451.** Journal of Forestry. 81(5): 293-295; 1983.

Concern about reforestation and to some extent about the financial viability of forest management on private land stimulated passage of Public Law 96-451, which includes tax incentives for reforestation. An economic analysis that measures the impact of the incentives on present net worth, cash flow, and internal rate of return under various landowner and forest situations indicates that the incentives will improve forestry's competitive positions with respect to other long-term capital investments.

DeVito, Anita S.; Miller, David R. **Some effects of corn and oak forest canopies on cold air drainage.** Agricultural Meteorology. 29: 39-55; 1983.

Nocturnal cold air drainage was examined in corn and oak canopies, and over a bare field on a hillside in Storrs, Connecticut. Smoke tracers, and vertical profiles of wind and temperature showed drainage flow development and persistence to be markedly affected by surface cover. The purpose of this study was to examine the effects of a low canopy, corn, and a tall canopy, oak forest, on the incidence and intensity of local nocturnal cold air drainage.

DeWalle, D. R.; Heisler, Gordon M. **Windbreak effects on air infiltration and space heating in a mobile home.** Energy and Buildings. (5): 279-288; 1983.

During winter experiments in central Pennsylvania a windbreak, 61m long and composed of a single row of white pine trees, significantly reduced air infiltration rates and space heating energy needs in a small mobile

me by up to 54 percent and 18 percent, respectively. Greatest reductions in air infiltration rates occurred with the home at one windbreak height (1H) downwind, even though maximum reductions in wind velocity occurred at 2H or 4H downwind. Space heating energy savings were less sensitive to downwind position, with maximum energy savings measured at both 1H and 2H. Maximum energy savings due to the windbreak for an entire winter heating season were estimated to be 12 percent.

DeWalle, David R.; Heisler, Gordon M.; Jacobs, Robert E. **Forest home sites influence heating and cooling energy.** *Journal of Forestry*. 81(2): 84-88; 1983. Experiments with small mobile homes in Pennsylvania indicated that shade of trees can significantly reduce solar heating and that by lowering wind speeds forests can lessen infiltration of outside air. Forests and windbreaks are especially effective with poorly sealed houses and in windy weather. On forested sites in most of the United States, energy use can probably be lessened by manipulating forest growth to allow the sun to strike the house in winter. On open sites, windbreaks and carefully located shade trees would lessen year-round energy use.

Rehner, L. S. **Air pollution impacts on forest trees: Abiotic and biotic stress factors.** In: Alekseyev, V. A.; Martin, J., eds. Publication Advisory Committee Academy of Sciences Estonian Socialist Soviet Republic, Tallinn; 1982: 18-19.

The objectives of this paper are to review the ecological implications of the deposition of atmospheric pollutants in predisposing forests to abiotic and biotic causal agents, and to propose research programs to explain the interactions of air pollutants and causal agents.

Rehner, Leon S. **The effects of acid precipitation and its gaseous precursors on forest composition, structure, growth, and productivity.** In: National acid precipitation assessment program: Effects research review; 1983 February 21-25; Raleigh, NC. Raleigh, NC: North Carolina State University; 1983: 2-4: 19-23.

In current studies, sustained acid fog at pH 2.7 altered the morphology of yellow-poplar leaves; studies of *rosophila* suggest somatic effects and germ line alterations after fumigation with SO₂; exposing field-grown pines to a linear gradient of SO₂ did not support the hypothesis that the recent emergence of *Scleroderma* in the Northeast is related to increased sulfur oxides; and preliminary analyses suggest that changes in ring width of white pine and red oak in New Hampshire and Ohio are correlated with climate where air pollution is extreme.

Rehner, Leon S. **The effects of acid precipitation and its gaseous precursors on forest composition, structure, growth, and productivity.** In: National acid precipitation assessment program: Effects research review; 1983 February 21-25; Raleigh, NC. Raleigh, NC: North Carolina State University; 1983: 2-4: A23. Abstract.

See previous reference.

Donley, David E. **Cultural control of the red oak borer (Coleoptera: Cerambycidae) in forest management units.** *Journal of Economic Entomology*. 76(4): 927-929; 1983.

Treated population levels of the red oak borer were reduced by 63 to 68 percent compared to untreated populations. Treatment of forest management units consisted of felling and sectioning all "brood trees" in ca. 34 ha of east-central Ohio oak/hickory stands. Less than 1 percent of the potential crop trees were sacrificed to treatment in each management unit. Costs ranged from \$16 to 18/ha, and benefits ranged from \$528 to 1,232/ha, assuming an 80-year timber management regimen. Red oak borer larvae (3- to 6-month-old) in felled trees were preyed on by ants and tunnels made by 12- to 20-month-old larvae were colonized by female ants.

Donley, David E. **Effect of timber stand improvement on population levels of the red oak borer, *Enaphalodes rufulus* Haldeman (Coleoptera: Cerambycidae).** In: Proceedings, 4th central hardwood forest conference; 1982 November 8-10; Lexington, KY. Lexington, KY: University of Kentucky Press; 1982: 47-50.

Population levels of the red oak borer were estimated over a 4-year period in six 25-year-old oak/hickory stands in east-central Ohio just before, during, and after timber stand improvement (TSI). Treated stands, 74 acres in total area had a site index of 60 to 70, an average basal area of 96 ft², and an oak component of 44 ft². Stand improvement consisted of cull-tree removal, an average 21 ft² per acre, by girdling and poisoning. Two stands were treated during the fall of 1977 when red oak borer larvae were in the cambium, and four stands were treated in the fall of 1978 when the borers were in the xylem. Borer attacks per 200-ft² units of host bark surface area were used as a population estimate. Treatment generation population levels were not reduced when TSI was applied to stands with larvae in the cambium. Posttreatment generation population levels in these stands were reduced from pretreatment levels by about 12 percent.

Dubois, Normand R. **New and better strains of *Bacillus thuringiensis*.** In: Proceedings, 1983 gypsy moth annual review; 1983 December 6-8; Albany, NY. Albany, NY: New York State Department of Environmental Resources; 1983: 30-33.

Several new strains of *Bacillus thuringiensis* (B.t.) were isolated from diseased spruce budworm larvae. Preliminary bioassays of laboratory preparations of these strains against this insect pest showed that three strains, NRD-8, NRD-10, and NRD-12, were about twice as potent as HD-1, the current strain of choice for commercial production of B.t. These observations were confirmed when fermentation beer concentrates of these strains and HD-1 were compared by parallel bioassay against 4th-instar budworm larvae. The potency of the three strains relative to *Heliothis virescens* and *Trichoplusia ni*, the insect species used to standardize B.t. products, was about the same as that of HD-1.

Dubois, Normand R. **Research aspects on the use of *Bacillus thuringiensis*.** In: Proceedings, 1982

National Gypsy Moth Review; 1982 December 7-9; Harrisburg, PA. Middletown, PA: Pennsylvania Department of Environmental Resources; 1983: 82-85.

Reports results of cooperative field studies with the Connecticut Agricultural Experiment Station to determine: (1) comparative field effectiveness between strain HD-1 and two experimental strains; (2) comparison between different application rates of HD-1; and (3) field confirmation of a synergism between Bacillus thuringiensis and Apanteles melanoscelus. Laboratory studies on the alteration of parasitism by Rogas lymantriae and selection of new strains of B. thuringiensis for use against gypsy moth are also reported.

Duchacek, H.; Sendak, P. E.; Laing, F. M. **Commercial-scale tubular maple sap evaporator: operation and economics.** Burlington, VT: University of Vermont Agricultural Experiment Station; 1982; Res. Rep. 31. 16 p.

Dyer, Kenneth L. **Effects on water quality of coal mining in the basin of the North Fork Kentucky River, Eastern Kentucky.** Water-Resources Investigations Report 81-215. Louisville, KY: U.S. Geological Survey; 1983. 94 p.

A detailed investigation of the effects of mine drainage on stream water quality was carried out on the watershed of the North Fork Kentucky River in 1975. Specific-conductance measurements were made at 415 sites, repeatedly at some of them. Discharge estimates and pH values, were also obtained in most instances while sulfate and chloride data were obtained about half the time.

Dyer, Kenneth L.; Curtis, Willie R. **pH in streams draining small mined and unmined watersheds in the coal region of Appalachia.** Res. Note NE-314. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 6 p.

To better evaluate the effects of surface mining for coal in first-order watersheds in Appalachia, a network of 421 water-quality sampling stations was established in 136 counties in nine states in 1977 and sampled on approximately a monthly basis until August 1979. Three categories of watersheds were sampled: (1) unmined, (2) mined after January 1972, and (3) mined before January 1972. Mean pH values averaged 7.0, 6.7, and 6.3 for these three categories of watersheds, respectively.

Echelberger, Herbert E.; Gilroy, Donna; Moeller, George. **Recreation research publications bibliography 1961-1982.** Washington, DC: U.S. Department of Agriculture, Forest Service; 1983. 94 p. Annotated list of recreation research publications, 1961-82.

Echelberger, Herbert E.; Leonard, Raymond E.; Adler, Steven P. **Designated-dispersed tent sites.** Journal of Forestry. 81(2): 90-91, 105; 1983.

Simple campsites away from trails and streams were marked in an attempt to disperse campers in heavily used eastern backcountry. Campers who used these

sites responded more favorably to the concept of dispersed camping than did those who stayed at trailside sites.

Eck, Ronald W.; Burks, Randall S.; Phillips, Ross A. **Optimal timing for upgrading low-volume rural roads.** In: Proceedings, 1983 winter meeting American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. St. Joseph, MI: American Society of Agricultural Engineers; 1983: Paper No. 83-1617.

A two-part approach to optimizing expenditures of road rehabilitation funds is presented. First, guided decisionmaking is used to determine whether a road line is a candidate for upgrading. In the second part, a zero-one integer programming algorithm is used to minimize upgrading, recurring maintenance, and vehicle operating costs for a given budget.

Edwards, Pamela J.; DeWalle, David R. **Spatial distribution of nutrients in throughfall beneath the crowns of three urban tree species.** Res. Briefs. 16(1): 6-8; 1983.

Edwards, Pamela J.; Halverson, Howard G.; DeWalle, David R. **Changes in precipitation chemistry yielded to urban runoff by tree crowns.** In: Proceedings, International symposium on urban hydrology, hydraulics and sediment control; 1983 July 25-28; Lexington, KY. Lexington, KY: University of Kentucky; 1983: 109-113.

Throughfall quantity and quality were measured under three replicate crowns of three urban tree species to assess possible impacts on urban runoff water quality. The interception process removed 17 to 37 percent of the precipitation volume from the runoff cycle for three summer storms. The acidic nature of precipitation was partially neutralized by reactions within the tree crowns. The throughfall had an average pH of 4.1 as opposed to 3.72 for precipitation. Although the sodium load of precipitation was not significantly affected, the loads of nitrogen, calcium, and potassium were increased by the tree crowns.

Eli, Robert N.; Biller, Cleveland J. **Timber harvest cableway location analysis using terrain models.** In: Proceedings, 1983 winter meeting American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. St. Joseph, MI: American Society of Agricultural Engineers; 1983: Paper No. 83-1615.

The problem of determining the most efficient layout of cableways in small forest harvest units in the Appalachian region is primarily a function of the steep complex terrain. An automatically drawn Triangulated Irregular Network Digital Terrain Model (TIN-DTM) is developed to provide accurate measures of area, aspect, slope, and distance within the harvested area.

Emanuel, David M. **Comparison of lumber values for Grade-3 hardwood logs from thinnings and mature stands.** Res. Pap. NE-529. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p. The lumber value per M bf (thousand board feet) by species (red oak, yellow-poplar, and hard maple) obtained from Grade-3 logs from a thinning cut was

gher than that from a mature-stand harvest operation. Red oak and yellow-poplar lumber values per M bf were significantly higher.

tkind, Paul H.; ODell, Thomas M.; Canada, Andrew T.; Shama, Steven K.; Finn, Amy M.; Tuthill, Robert.

The gypsy moth caterpillar: A significant new occupational and public health problem. *Journal of Occupational Medicine*. 24(9): 659-662; 1982.

When volunteers were skin tested with extracts of gypsy moth hairs, there was a strong relationship between reactions and dermatologic and/or pulmonary problems associated with exposure to gypsy moth larvae. This helps explain the outbreak of cutaneous reactions in the general population during the gypsy moth outbreak in 1981.

ay, S.; Leak, W. B. **Ecological land classification: practice and research on the WMNF.** In: *In-place resource inventories: Principles and practices*; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters; 1981: 654-658.

ederer, C. A. **Improving forest hydrology research.** In: *Proceedings, 1982 Canadian hydrology symposium*; National Research Council of Canada; 1982: 653-663.

Hydrology models need to be developed into a component of ecosystem models. The problems of sediment and floods are well enough understood in most geographic areas. The problems of soil nutrient status and acid precipitation effects will require long-term efforts. We are in the early stages of a revolution in the collection of data and the transfer of both data and knowledge. Forest hydrologists have lagged in making their knowledge available to users. Generalization and simplified techniques are needed.

ederer, C. A. **Nitrogen mineralization and nitrification: Depth variation in four New England forest soils.** *Soil Science Society of America Journal*. 47(5): 1008-1014; 1983.

Examines the dependence of mineralization and nitrification on horizon throughout the soil profile in mature forests, by incubating soil in situ in buried bags.

isher, Edward L.; Peters, P. A. **Analysis of eastern United States cable harvesting operations.** In: *Proceedings, 1982 Winter Meeting American Society of Agricultural Engineers*; 1982 December 14-17; Chicago, IL. St. Joseph, MI: American Society of Agricultural Engineers; 1983: Paper No. 82-1602.

leischer, H. O.; Foulger, A. N. **A brief history of the Society of Wood Science and Technology: The first twenty-five years 1958 to 1983.** Madison, WI: Society of Wood Science and Technology; 1983. 28 p. Founded in 1957, The Society of Wood Science and Technology celebrated its 25th birthday with 524 members in 1982. This paper traces its history for the first 25 years.

Frank, Robert M. **Balsam fir (*Pinaceae Abies balsamea*) silvics, silviculture, and natural regeneration methods.** In: Wingard, Charles; Koller, Norman, eds. *Proceedings, silvicultural guides workshop*

Chippewa and Superior National Forests; 1983: February 14-18; Grand Rapids, MN. Duluth, MN: USDA Forest Service, Superior National Forest; 1983: 114-136.

Presents the silvics and silviculture of balsam fir and natural regeneration methods for developing forest stands less vulnerable to spruce budworm. Emphasis is on several of the options available for increasing the spruce component in spruce-fir stands.

Frank, Robert M. **A focus on natural regeneration methods for developing a spruce-fir forest less vulnerable to spruce budworm.** In: *Proceedings, 1983 Eastern Spruce Budworm Research Work Conference*; 1983 January 10-11; Orono, ME. Orono, ME: University of Maine; 1983: 18. Abstract.

Study results from several locations in Maine indicate that natural regeneration and timber-stand-improvement techniques can be successful in developing stands more resistant to spruce budworm attack.

Frank, Robert M., Jr.; O'Keefe, Timothy G. **A transfer system to reach a selected audience: Woodlot owners and mill managers.** In: *Proceedings, technology transfer society international symposium*; 1983 June 20-22; Chicago, IL. Chicago, IL: Illinois Institute of Technology Research Institute; 1983: 371-378.

Under the USDA Forest Service CANUSA program, a great deal of technical information about control of spruce budworm has been developed. Much of this information has direct application for woodlot owners, and the utilization of budworm-killed timber can be helpful information for mill managers. Unfortunately, only a limited amount of this data has thus far reached these ultimate consumers.

Gabriel, William J. **Genetic improvement in sap-sugar production.** In: *Sugar maple research: sap production, processing, and marketing of maple syrup*. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 38-41.

Discusses the difference in the sugar content of tree sap. This difference makes it possible to improve sugarbush production in two ways: existing sugarbushes can be thinned by removing the trees that produce less sugar (as shown in tests of the sap from individual trees), and the productiveness of sugar maple trees can be improved over a long term by selective breeding.

Galford, Jimmy R. **Life history of the red oak borer, *Enaphalodes rufulus* (Haldeman), in white oak (*Coleoptera: Cerambycidae*).** *Entomological News*. 94(1): 7-10; 1983.

Young red oak borer larvae feed horizontally in white oak but mostly vertically in red, black, and scarlet oak. Overgrowths of successful attacks in white oak appear as "L" or reverse "L" marks on the trees. In a study in central and southern Ohio between 1977 and 1981, 27 of 457 trees examined in the basal 6 feet had borer injuries. Only small, suppressed trees were injured.

Gansner, David A. **Update of PA-USFS risk rating project.** In: *Proceedings, 1982 national gypsy moth review*; 1982 December 7-9; Harrisburg, PA. Harrisburg, PA: Pennsylvania Department of Environmental Resources; 1983: 147.

Field plots installed in advance of gypsy moth outbreaks will be used to monitor impacts of the insect as it spreads to new frontiers of forest vegetation. They will also provide data needed to improve techniques for predicting and evaluating damages.

Gansner, David A.; Casey, Lloyd R. **Hey, woodland owner...Check your value growth rate.** Pennsylvania Forests. 73(5): 4-5; 1983.

Presents an easy method for estimating the current rate of value growth for trees and timber stands. A wise woodland owner keeps close tabs on the financial earnings of his timber. And all he needs is a diameter tape, an increment borer, and the table shown in this paper.

Gansner, David A.; Herrick, Owen W.; DeBald, Paul S.; Acciavatti, Robert E. **Changes in forest condition associated with gypsy moth.** Journal of Forestry. 81(3): 155-157; 1983.

Eight years after the beginning of repeated but not continuous attacks by the gypsy moth, hardwood plots in the Pocono Mountain region of Pennsylvania had outgrown most losses. Basal area averaged close to preattack values, though with wide variation from plot to plot. Volumes per acre had gained an average of 8 percent. Before the outbreak, 87 percent of the plots were fully stocked or overstocked; after 8 years, 79 percent were in this condition but with a reduced oak component.

Gansner, David A.; Herrick, Owen W.; DeBald, Paul S.; Cota, Jesus A. **New turf for gypsy moth: There's more at risk downrange.** Res. Pap. NE-519. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p.

Data collected from 600 field plots in central Pennsylvania forests threatened by gypsy moth point to a greater potential for damage downrange. Though greater than in the Poconos, losses are not expected to be spectacular. Still, some forest landowners will suffer heavy tree mortality to the pest.

Garrett, L. D.; Morselli, M. F.; Jenkins, W. L. **Potential discrepancies in applying U.S. and Canadian syrup color standards.** Maple Syrup Digest. 23(4): 26-28; 30-32; 34-35; 1983.

With both the U.S. visual method and the Canadian spectrophotometric method, we color-graded 120 maple syrups produced and graded in Vermont and 53 syrups produced and graded in Canada. Results indicated that the spectrophotometric measure of variation corresponding to each of the U.S. visual grades is lower than that specified in the Canadian standards.

Garrett, Lawrence D. **Efficiency of wood-fueled evaporators.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 83-86.

Discusses the factors affecting efficiency and economics of using wood fuels.

Garrett, Lawrence D. **Moisture loss from felled eastern hardwood and softwood trees.** In: Proceedings, 6th international FPRS industrial wood energy forum; 1982 March 8-10; Washington, DC. Madison, WI: Forest Products Research Society; 1983: 210-214.

Garrett, Lawrence D.; Huyler, Neil K.; Sendak, Paul E. **Improvements in sap processing techniques.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 87-97.

Describes research to develop a sap preheater that not only achieved the same increase in efficiency as the series flow design, but was easier to make, especially for a sugarmaker; was flexible enough to fit under the many types of steam hoods already in place; and had a lower sap feed head requirement. The design that satisfied these goals was the parallel flow preheater.

Garrett, Peter W.; Fleming, Harvey. **Pitch pine.** In: Silvicultural systems for the major forest types of the United States. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 135-136.

Gatchell, Charles J. **Utilizing low-quality hardwoods.** In: Proceedings, hardwood forest management and utilization symposium; 1982 October 25-26; Orono, ME. Misc. Rep. 279. Orono, ME: University of Maine, Maine Agricultural Experiment Station; 1983: 35-40.

Gatchell, Charles J.; Anderson, R. Bruce; Araman, Philip A. **Effect of gang-ripping width on CIF yields from No. 2 Common oak lumber.** Forest Products Journal. 33(6): 43-48; 1983.

Using computer simulation, we gang ripped a 4,200-board-foot oak data bank to 2-, 2-1/2, or 3-inch primary widths with salvage to a minimum size of 1 inch wide by 10 inches long. Overall random-length yield of CIF cuttings was 60 percent regardless of primary ripping widths. Narrower ripping widths produced more individual pieces and a greater number of longer pieces. Half or more of the accumulated surface area of random-length cuttings was in cuttings 40 inches or longer. More than 75 percent of the surface area of cuttings was in pieces with widths of 2 inches or more.

Gatchell, Charles J.; Hansen, Bruce G. **Let's talk the same economic language when evaluating System 6 and standard-size hardwood blanks.** NE-INF-49-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 6 p.

Presents the economic terminology and economic analysis approach used by the Forestry Sciences Laboratory in the evaluations of System 6 and standard blanks. Introduces the layman to the terms and procedures described in the technical presentations of our technology transfer workshops.

Gill, J. D. **Wildlife and other multiple use considerations.** In: Proceedings, Fuelwood Management and Utilization Seminar; 1982 Nov. 9-11; East

- Lansing, MI. East Lansing, MI: Michigan State University; 1982: 106.
- he increased demand for firewood threatens the habitat of many wildlife species. Dead or dying trees that commonly are cut for firewood are vital to wildlife species that nest in tree cavities. Likewise, healthy trees of many species preferred for firewood are important components of wildlife habitat. Tree species or species groups are value-rated for both firewood and wildlife so that the ratings can be used to decide how to manage a woodland for fuel and wildlife.
- ill, John D.; Worley, David P. **Managing nonindustrial private forestlands: a different approach.** In: America's hardwood forests—opportunities unlimited. Proceedings, 1982 Convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American Foresters; 1983: 238-242.
- describes and comments on the objectives, framework, and results of a workshop conducted jointly by the Ohio chapters of the Society of American Foresters, the Soil Conservation Society of America, and the Wildlife Society. These chapters explored what may be the entrance to a pathway through a "hopeless morass" of institutional and governmental complexity that may impede efforts to improve management of nonindustrial private forests.
- odwin, P. A.; Shields, K. S. **Some interactions of *Serratia marcescens*, nucleopolyhedrosis virus and *Blepharipa pratensis* Dip. [Tachinidae] in *Lymantria dispar* [Lep.: Lymantriidae].** Entomophaga. 27(2): 189-196; 1982.
- he entomopathogens *Serratia marcescens* Bizio and nucleopolyhedrosis virus were each fed alone and in combination with the parasite *Blepharipa pratensis* (Meigen) to 4th-instar gypsy moth, *Lymantria dispar*, (L.) larvae. At LD₅₀ for NPV, the presence of the parasite enhanced polyhedrosis about 30 percent, but the total number of gypsy moth larvae and pupae killed (85 percent) was not significantly different from the number killed by the parasite alone (93 percent). When the parasite was combined with *S. marcescens*, a strain nonpathogenic in *L. dispar*, total mortality was not significantly different from that in insects exposed only to the parasite (89 and 86 percent, respectively), but parasite survival was reduced about 12 percent. However, deaths not attributable to the parasite could not be ascribed to the bacterium either.
- odwin, Paul A.; Valentine, Harry T.; Odell, Thomas M. **Identifying pine bark weevils by discriminant analysis.** BioScience. 33(3): 198; 1983.
- condensation of "The identification of *Pissodes* [Coleoptera: Curculionidae] using discriminant analysis," published in Annals of the Entomological Society of America 75(6).
- oldstein, E. L.; Gross, M.; DeGraaf, R. M. **Wildlife and greenspace planning in medium-scale residential developments.** Urban Ecology. 7: 201-214; 1983.
- he spatial arrangement of woody vegetation in residential developments from 40 to 1,000 ha is analyzed in terms of the "species-area curve" and other principles of island biogeography. These principles, which predict the number of wildlife species that will occur in an area as a function of the size, shape, and distribution of vegetation patches in the area, promise to be a powerful tool in greenspace planning. Using birds as an example, we examine some of the trade-offs among wildlife, visual, and recreational amenities which are associated with three different approaches to the arrangement of a given amount of greenspace. These three approaches are examined both at the scale of small and large subdivisions and at a micro-regional scale of 10 km².
- Gottschalk, Kurt W. **Management strategies for successful regeneration: oak-hickory.** In: Finley, J.; Cochran, R. S.; Grace, J. R., eds. Proceedings, 1983 Penn State forestry issues conference, regenerating hardwood stands; 1983 March 15-16; University Park, PA. University Park, PA: Penn State University; 1983: 190-213.
- To obtain successful oak regeneration, advance oak seedlings of relatively large size with well established root systems must be present before cutting. Establishment and growth of advance regeneration is influenced by site quality, soil moisture, light, predation, and interference from other vegetation. Either central hardwood or Allegheny hardwood guides can be used to determine the adequacy of oak advance regeneration. Successful regeneration of oak can be obtained using even-age management strategies. Both clearcutting and shelterwood cutting are used depending upon the adequacy of advance regeneration. Understory control using an herbicide treatment may also be required. Uneven-age management strategies will usually not regenerate oaks successfully, but group selection cutting may provide some oak regeneration if sufficient advance regeneration was present.
- Gottschalk, Kurt W. **Silvicultural alternatives for coping with the gypsy moth.** Connecticut Timber Trends. 4(3): 6-10; 1983.
- Silvicultural control of gypsy moth populations is not a new idea. Suggestions for silvicultural control were made as early as 1913 but recently interest again has started to increase, in part due to restrictions on chemical control methods and ever-increasing areas of gypsy moth impact.
- Greenblatt, Jane A.; Barbosa, Pedro; Montgomery, Michael E. **Host's diet effects on nitrogen utilization efficiency for two parasitoid species: *Brachymeria intermedia* and *Coccygomimus turionellae*.** Physiological Entomology. 7: 263-267; 1982.
- Differences in the weight of parasitoid individuals of *Brachymeria intermedia* (Nees) and *Coccygomimus turionellae* (L.) (Ichneumonidae) were found to be associated with differences in host diet. The availability of the host nitrogen to the parasitoids differed depending on the sex of the host, *Lymantria dispar*, and its diet. Nitrogen utilization efficiency (NUE) for both parasitoid species were inversely correlated with host weight and with host nitrogen.
- Greenleaf, R. D.; Echelberger, H. E. **Backpacker satisfaction in the White Mountains.** Appalachia. 1982 December: 112-113.

For most backpackers interviewed on two trails in the White Mountains of New Hampshire, the number of parties met on the trail had little effect on their satisfaction. When use levels were well below expectations, most people were unaffected while a few were more satisfied. When use was much higher than expected, most still remained unaffected while a few indicated some dissatisfaction. Privacy and solitude while hiking did not seem to be of great importance in these two settings.

Gregory, G. F. **Fungicide injection and pruning for control of Dutch elm disease in Greenfield Village, Michigan.** In: Proceedings of a conference on urban and suburban trees: Pest problems, needs, prospects and solutions; 1982 April 18-20; East Lansing, MI. East Lansing, MI: Michigan State University; 1982: 49-52.

In a 1974 study, elms with foliar symptoms of Dutch elm disease were injected with 226 ml of 6 g/liter solution of methyl 2-benzimidazole carbamate salt per cm of dbh. Symptomatic limbs were also injected, and later pruned off. After 5.5 years, 25 percent of these trees had no foliar symptoms; of those that had symptoms in less than 10 percent of the crown, 33 percent were symptom-free after 5.7 years.

Gregory, Robert A. **Release of sap sugar and control of sap pressure.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 1-7.

Discusses what controls sap sweetness and what causes sap to flow from a taphole.

Gregory, Robert A.; Hawley, Gary J. **Sap extraction and measurement of soluble sap sugars in sugar maple.** Canadian Journal of Forest Research. 13(3): 400-404; 1983.

Techniques are described for field and laboratory extraction of small quantities of sugar maple xylem sap when pressure in the xylem is less than atmospheric. Accurate estimates of sap sugar concentration can be made with a hand refractometer most of the year. There is, however, appreciable within-tree variation in sap sugar concentration at any given time and within short periods of time.

Grimble, D. G.; Morris, O. N. **Regional evaluation of B.t. for spruce budworm control.** Agric. Inf. Bull. No. 458. Washington, DC: U.S. Department of Agriculture; 1983. 9 p.

The cooperation of regional pest control officials in collecting similar data from their own spray programs has allowed the first comparison of B.t. performance over a wide area. B.t. is the only biological or microbial safe insecticide available for spruce budworm control. Indeed, it is likely to be the only alternative to chemical pesticides in the foreseeable future. B.t. treatments sometimes fail to achieve acceptable results, just as chemical insecticides do, but given reasonable conditions of use, B.t. is usually successful in protecting foliage. At present, B.t. must be considered a viable alternative for chemicals in many situations, especially in environmentally sensitive areas where foliage protection is the goal.

Haeskeylo, E. **Researching the potential of forest tree mycorrhizae.** Plant and Soil. 71(1): 1-3; 1983. During the last century important ecological and physiological principles in mycorrhizal associations were discovered. Reconsideration of this era of mycorrhizal research is worthy of current consideration since progress particularly in physiology has been slow. To derive the potentially vast benefits from mycorrhizal associations in field applications and to achieve genetic alteration to improve physiological benefits derived from mycorrhizas, fundamental characteristics and biochemical mechanisms in the fungus-root complex must be better understood.

Haeskeylo, Edward. **Effects of extended in vitro culture on infectivity and vitality of selected ectomycorrhizal fungi.** In: Proceedings, 5th North American Conference on Mycorrhizae; 1981 August 16-21; Quebec, Canada. Quebec, PQ: University of Laval; 1981. Abstract.

Hagerty, J. K.; Stevens, T. H.; Allen, P. G.; More, T. **Benefits from urban open space and recreational parks: a case study.** Journal of Northeastern Agriculture Economic Council. 6(1): 13-20; 1982.

Halverson, H. G.; Corbett, E. S.; Heisler, G. M. **USDA studies urban forests and municipal watersheds.** Science in Agriculture. 30(2): 13; 1983.

Summarizes results emerging from the joint and cooperative research between the USDA Forest Service's Northeastern Forest Experiment Station and Penn State. The mission to evaluate forest resource benefits includes studies on: forests examined as sound absorbers, how forests aid home heating and cooling, how timber harvesting aids water resource, and forests and acid rain.

Halverson, Howard G. **Cycling of materials from atmospheric deposition in urban forest ecosystems.** In: Proceedings, national acid precipitation assessment program; 1983 February 21-25; Raleigh, NC. Raleigh, NC: North Carolina State University; 1983: A5, 21-26.

Examines the mediating effects of one type of terrestrial ecosystem, the urban forest, on water quality. Specifically, efforts have been focused on tree surfaces and their impact on throughfall and stemflow chemistry. The impact of other common urban surfaces on water quality is also being investigated.

Halverson, Howard G.; DeWalle, David R.; Sharpe, William E. **Seasonal variations of precipitation, stemflow, and throughfall chemistry in a suburban area.** In: Proceedings, 2nd national urban forestry conference; 1982 October 10-14; Cincinnati, OH. Washington, DC: American Forestry Association; 1983: 352. Poster session abstract.

Hanna, C. Mark; Lynch, J. A.; Corbett, E. S. **Watershed responses and stormflow chemistry changes following precipitation.** Res. Briefs. 16(1): 15-16; 1983.

Hansen, Bruce G.; Reynolds, Hugh W. **The economics of System 6 processing of standard-size blanks.** NE-INF-47-83. Broomall, PA: U.S. Department of

- Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p.
- Presents System 6, needed raw material, product outputs, and yields. Discusses the economics to show the product costs to potential producers who wish to use the blanks internally, and the investment potential (IRR and NPV) to potential producers who wish to sell blanks.
- Harrison, Richard G.; Wintermeyer, Stephen F.; Odell, Thomas M. **Patterns of genetic variation within and among gypsy moth, *Lymantria dispar* (Lepidoptera: Lymantriidae), populations.** *Annals of the Entomological Society of America.* 76(4): 652-656; 1983.
- Based on analysis of allozyme variation at 20 loci, gypsy moth populations in the United States exhibit extremely low levels of genetic variability compared with European populations. The loss of variability is suggested to be a consequence of the population bottleneck that accompanied the introduction of the moth into North America. A single collection of gypsy moths from Japan not only exhibits high levels of variability but also is genetically distinct from European and North American populations.
- Harrje, David T.; Buckley, Charles E.; Heisler, Gordon M. **Building energy reductions: windbreak optimization.** *Proceedings of the American Society of Civil Engineers.* 108: 143-154; 1982.
- Hayslett, Homer T., Jr.; Solomon, Dale S. **A matrix model for predicting foliage weight of trees by age classes.** *Mathematical Biosciences.* 67: 113-122; 1983.
- A Leslie-type matrix has been developed to model the annual growth of foliage on individual trees for any species that retains its foliage for more than 1 year. Although the model is a general one, applicable to any species that has age classes of foliage, it is developed with occasional references to balsam fir. For a data set of 66 dominant and codominant balsam fir trees, the model predicted the weights of the first three age classes of foliage accurately (less than 10 percent error) over a 6-year period. There was a 23 percent error for all age classes combined.
- Healy, Bill; Nenno, Sam. **Winter feeding—some food for thought.** *Turkey Call.* 10(5): 16-18; 1983.
- Sportsmen often believe that turkeys must be artificially fed during winter. Feeders may help some birds, but experience has shown that direct feeding has no effect on populations. Individual landowners can manage turkey habitat, but the results are often difficult to assess because of the turkey's large home range. Habitat conditions are improving on public forests in the Northeast, because timber and wildlife activities are well coordinated and the forests are growing older. Direct management of spring seeps, which are key winter feeding areas, is being tried on the Monongahela National Forest. Maintaining turkey populations in the Northeast will depend on the interactions among individual landowners, public land managers, population inventories, and hunting regulations.
- Healy, William M.; Nenno, Edward S. **Minimum maintenance versus intensive management of clearing for wild turkeys.** *Wildlife Society Bulletin.* 11(2): 113-120; 1983.
- Clearings are managed for wild turkeys in most eastern states, and we evaluated these practices and the relative values of clearings and young clearcuts. We found that old fields and annually maintained grass/forb communities provided the same benefits for poults as clearings managed by traditional agricultural methods. Poults found more to eat in clearings than in 2-year-old clearcuts, but excellent forest sites (SI 80) produced brood habitat both in clearings, clearcuts, and closed-canopy forest stands. Fair sites (SI 65) produced brood habitat only in clearings. We recommend managing clearings by the simplest method that maintains the herbaceous community.
- Healy, William M.; Pack, James C. **Managing seeps for wild turkeys in northern hardwood forest types in West Virginia.** In: Yahner, Richard H., ed. *Transactions of the Northeast Section, The Wildlife Society: 40th Northeast Fish and Wildlife Conference; 1983 May 15-18; West Dover, VT.* [Publisher unknown]; 1983: 9-18.
- Seeps are important winter feeding areas for wild turkeys. Thinning around seeps increased herbaceous ground cover, average tree diameter, and relative dominance of mast-producing trees. Where white-tailed deer were abundant, clearcutting produced savannah-like openings characteristic of turkey brood range. Where deer were less numerous, 3-year-old clearings were regenerating but were dominated by blackberries. Seeps on southern aspects and lower slopes should be managed as winter feeding areas for turkeys. The choice of treatment will depend on the condition of the surrounding forest and abundance of deer.
- Heisler, Gordon, M. **Models of tree shade patterns as tools for designing tree arrangements to save energy.** In: *Proceedings, 2nd national urban forestry conference; 1982 October 10-14; Cincinnati, OH.* Washington, DC: American Forestry Association; 1983: 351. Poster session abstract.
- Helvey, J. D.; Hubbard, John; DeWalle, David R. **Time trends in pH and specific conductance of streamflow from an undisturbed watershed in the central Appalachians.** In: *Proceedings, Canadian Hydrology Symposium; 1982 June 14-15; Fredericton, NB.* NRCC 20548. Fredericton, NB: National Research Council of Canada, Associate Committee on Hydrology; 1982: 637-651.
- A test for a trend in stream pH between 1951 and 1978 was inconclusive because of problems associated with instrument changes in 1966 and 1975. However, the pH of the stream has changed very little, if any, during the past 14 years. Average annual specific conductance has increased significantly since 1968, but the cause is uncertain. Precipitation acidity may be leaching increasing amounts of cations, especially calcium, from the soil matrix.
- Helvey, J. D.; Kochenderfer, J. N. **Effects of acid precipitation on nutrient cycling and weathering of minerals in the Central Appalachians.** In: *National acid precipitation assessment program effects; research review.* [Date of meeting unknown.] Raleigh, NC. Raleigh, NC: North Carolina State University: 47-54; 1983.

Because the Central Appalachians are the first barrier to many storms moving from west to east over highly industrialized areas of the Midwest, atmospheric pollutants from the Midwest have a high probability of being deposited in this area. We need to monitor acid precipitation and the chemical characteristics of streamflow from undisturbed watersheds, especially those where historical records of stream chemistry are available. These watersheds will provide an early warning if and when acid precipitation begins to overwhelm the buffering capacity of the system. If timber harvest significantly reduces watershed buffering capacity, management plans might have to be altered.

Helvey, J. D.; Kochenderfer, J. N. **Effects of acid precipitation on nutrient cycling and weathering of minerals in the Central Appalachians.** In: National acid precipitation assessment program effects; research review. Raleigh, NC; Raleigh, NC: North Carolina State University: 2-3; 1983. Abstract. See previous entry.

Helvey, J. D.; Patric, J. H. **Sampling accuracy of pit vs. standard rain gages on the Fernow Experimental Forest.** Water Resources Bulletin. 19(1): 87-89; 1983.

Catch in standard (unshielded) rain gages exposed 3 feet above the land surface was compared with catch in pit (buried) gages exposed 1 inch above the land surface. These tests confirmed that catch in standard gages underestimates point rainfall in forest openings, as well as in conventional weather stations. Pit gages caught significantly ($P=0.05$) more rain than did standard gages at each of four locations tested. Catch increases ranged from 2.3 to 3.4 percent.

Herrick, Owen W. **Estimating benefits from whole-tree chipping as a logging innovation in northern U.S. forests.** Forest Products Journal. 32(11/12): 57-60; 1983.

Two supply schedules were estimated for pulpwood production quantities and prices—with and without adoption of whole-tree chipping technology. Whole-tree chipping in 1979 created benefits equal to a 2 percent cost reduction spread across the entire hardwood pulpwood supply system.

Herrick, Owen W. **Estimating innovation benefits: Whole-tree chipping in Northern U.S. forests.** In: America's hardwood forests—opportunities unlimited. Proceedings, 1982 Convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American foresters; 1983: 245-247.

Discusses the link between research and its application that can help direct resources for research and development toward innovations that will do most to improve society's productivity, well-being, or economic status.

Hilt, Donald E. **Individual tree diameter growth model for managed, even-aged, upland oak stands.** Res. Pap. NE-533. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 15 p.

A distance-independent, individual-tree diameter growth model was developed for managed, even-aged,

upland oak stands. The 5-year basal-area growth of individual trees is first modeled as a function of d.b.h. squared for given stands. Parameters from these models are then modeled as a function of mean stand diameter, percent stocking of the stand, and site index. A stochastic option for the overall model also was developed. Tests on data from managed stands revealed that the model performed well.

Hilt, Donald E.; Rast, E. D.; Bailey, H. **Predicting diameters inside bark for 10 important hardwood species.** Res. Pap. NE-531. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 7 p.

General models for predicting DIB/DOB ratios up the stem, applicable over wide geographic areas, are developed for 10 important hardwood species. Results indicate that the ratios either decrease or remain constant up the stem. Methods for adjusting the general models to local conditions are presented. The prediction models can be used in conjunction with optical dendrometer measurements or stem taper equations to convert outside bark diameters to inside bark diameters.

Hornbeck, J. W. **Book review—Acid rain: An issue in Canadian-American relations by J. E. Carroll.** Journal of Forestry. 81(4): 248; 1983.

This book is discussed in terms of its interest and value to the forestry profession.

Hornbeck, James. **Review of "Structure and function of northern coniferous forests,"** T. Persson, ed. Environmental Education and Information. 2(4): 328-329; 1982.

Hornbeck, J. W.; Martin, C. W.; Bloxam, R. M.; Munn, R. E.; Likens, G. E.; Weisman, B. **Relationships of storm type and trajectory to precipitation chemistry.** In: Acid precipitation—Abstracts. A technical symposium on acid rain transport and transportation phenomena; 1983 September 21-23; Burlington, VT. Burlington, VT: University of Vermont; 1983.

Hornbeck, James W.; Kropelin, William K. **Estimating biomass and nutrient removal from a northern hardwood harvest.** Journal of Forestry. 81(5): 287-288, 332; 1983.

We compared actual removals of biomass and nutrients from a whole-tree harvest with estimates made from biomass equations and nutrient data in the literature. The estimated values from the literature were suitable for assessing impacts of nutrient removals, but they overestimated biomass removals by an average of 19 percent.

Hornbeck, James W.; Peterson, Florence; Edwards, Nelson T. **Effects of whole-tree harvesting on soil carbon transfer.** Bulletin of the Ecological Society of America. 64(2): 189; 1983. Abstract.

Horsley, S. B. **Interference with desirable northern hardwood regeneration by herbaceous and woody plants.** In: Finley, J.; Cochran, R. S.; Grace, J. R., eds. Regenerating hardwood stands: Proceedings of a symposium; 1983 March 15-16; University Park, PA. University Park, PA: The Pennsylvania State University; 1983: 81-93.

Interference phenomena play an important role in regeneration of desirable northern hardwood regeneration in Pennsylvania. Allelopathic interference by herbaceous weeds is the primary reason orchard stands and savannahs fail to regenerate. Studies of the independent effects of weeds and deer in shelterwood cut Allegheny hardwood stands demonstrate that under appropriate conditions, each has substantial interfering effects with desirable regeneration. Understories of striped maple and beech frequently exclude desirable species of reproduction. We are presently able to take remedial action in all of these situations with herbicides; however, the challenge of the future is to learn how interference phenomena work, so that they can be avoided.

Horsley, S. B.; Marquis, D. A. **Interference by weeds and deer with Allegheny hardwood reproduction.** Canadian Journal of Forest Research. 13(1): 61-69; 1983.

Deer browsing and interference from forest weeds, particularly hayscented fern, New York fern, and short husk grass, influence the establishment of Allegheny hardwood reproduction. We determined the independent interference by deer and weeds after a seed cut and a removal cut in a two-cut shelterwood sequence.

Horsley, Stephen B. **Competitive and allelopathic interference in Allegheny Plateau forests.** In: Proceedings, North American symposium on allelopathy, program, abstracts and participants; 1982 November 14-17; Champagne-Urbana, IL. Champagne-Urbana, IL: University of Illinois; 1983: 14. Abstract.

Horsley, Stephen B.; Bjorkbom, John C. **Herbicide treatment of striped maple and beech in Allegheny hardwood stands.** Forest Science. 29(1): 103-112; 1983.

Three small-plot experiments evaluated herbicides for killing striped maple and beech. Glyphosate, applied to striped maple or beech in uncut stands, produced a high degree of kill. Applications of 2,4,5-T in an uncut stand killed at least 97 percent of the striped maple, and did not interfere with subsequent development of desirable species of advance reproduction. Bromacil, 5 percent picloram pellets, and 10 percent picloram pellets were applied to striped maple in a 12-year-old clearcut. About 90 percent of the striped maple were killed with all rates of bromacil, rates of 6.72 kg/ha a.i. or more of 5 percent picloram pellets, and 8.96 kg/ha a.i. or more of 10 percent picloram pellets. Survival and height growth of white ash seedlings subsequently planted on the site were not significantly reduced by any rate of application of any of the herbicides.

Houseweart, Mark W.; Jennings, Daniel T.; Welty, Celeste; Southard, Susan G. **Progeny production by *Trichogramma minutum* (Hymenoptera: Trichogrammatidae) utilizing eggs of *Choristoneura fumiferana* (Lepidoptera: Tortricidae) and *Sitotroga cerealella* (Lepidoptera: Gelechiidae).** The Canadian Entomologist. 115(10): 1245-1252; 1983.

Mean daily progeny production by *Trichogramma minutum* ("Maine strain") was 15.2 in *Choristoneura fumiferana* and 10.9 in *Sitotroga cerealella* eggs. Total

progeny production was higher in *S. cerealella*, but not significantly different from that of *C. fumiferana* eggs. Significantly more eggs were deposited by *T. minutum* the first day than in subsequent days regardless of host. We found no significant relationship between progeny produced by females and the day of male death as previously reported. Ratio of females: males decreased significantly with increasing age and oviposition activity of the mother. The oviposition period spanned 68 percent of the female's life span when *S. cerealella* eggs were available; whereas females spent significantly less time (60 percent) ovipositing in *C. fumiferana* eggs.

Houseweart, Mark W.; Southard, Susan G.; Jennings, Daniel T. **Availability and acceptability of spruce budworm eggs to parasitism by the egg parasitoid, *Trichogramma minutum* Riley (Hymenoptera: Trichogrammatidae).** The Canadian Entomologist. 114: 657-666; 1982.

Spruce budworm egg deposition spanned 27 days during both 1979 and 1980. The egg deposition curve is essentially a normal bell-shaped distribution with a slight skew to the right. Spruce budworm eggs are most acceptable to *Trichogramma minutum* for successful parasitism during the earlier stages of host-egg development. Parasitism rates at 2 different temperatures (21°C and 27°C) were significantly greater for 1- to 3-day-old eggs than for 6- to 8-day-old spruce budworm eggs. Major reduction in host-egg acceptability occurred after the 5th day at 21°C and after the 4th day at 27°C.

Houston, D. R. **Effects of parasitism by *Nematogonum ferrugineum* (*Gonatorrhodiella highlei*) on pathogenicity of *Nectria coccinea* var. *faginata* and *Nectria galligena*.** In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 28; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 109-114.

The mycoparasite *Nematogonum ferrugineum* (*Gonatorrhodiella highlei*) was associated commonly with *Nectria galligena* cankers on *Betula lenta* in New Hampshire and Connecticut, and was isolated from *N. galligena* cankers on *Juglans nigra* from Virginia. In inoculation trials, parasitized isolates of *N. coccinea* var. *faginata* and *N. galligena* spread more slowly than nonparasitized isolates in bark and cambial tissues; parasitized *N. coccinea* var. *faginata* produced fewer perithecia.

Houston, D. R. **Influence of lichen species on colonization of *Fagus grandifolia* by *Cryptococcus fagisuga*: preliminary observations from certain Nova Scotian forests.** In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 28; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 105-108.

Some crustose lichens that colonize the stems of beech trees favor infestation by *Cryptococcus fagisuga*, while others do not favor infestation. A predominance of species unsuited for infestation seems to be a reason why trees growing on some sites in Nova Scotia are remarkably free of beech bark disease.

Houston, David R. **American beech resistance to *Cryptococcus fagisuga***. In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 8; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 38-42.

American beech trees that were free of beech bark disease in forests long-affected by beech bark disease were challenged with *Cryptococcus fagisuga* using the 'foam' technique. Trees were resistant: no insects reached maturity. In Nova Scotia, 12 to 15 disease-free trees per hectare occurred in the stands examined. Many of these trees occurred in groups.

Houston, David R. **Diebacks and declines of urban trees**. In: Proceedings, International symposium on urban horticulture; 1983 June; New York, NY. New York, NY: New York Botanical Garden, Institute of Urban Horticulture; 1983.

Houston, David R. **American beech resistance to *Cryptococcus fagisuga***. In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 8; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 38-42.

American beech trees that were free of beech bark disease in forests long-affected by beech bark disease were challenged with *Cryptococcus fagisuga* using the 'foam' technique. Trees were resistant: no insects reached maturity. In Nova Scotia, 12 to 15 disease-free trees per hectare occurred in the stands examined. Many of these trees occurred in groups.

Houston, David R. **Basic concepts of diebacks-declines**. In: Urban and suburban trees: pest problems, needs, prospects, and solutions; 1982 April 18-20; East Lansing, MI. East Lansing, MI: Michigan State University; 1982: 57-60.

Diebacks and declines are complex in cause and effect. They are triggered by the predisposing effects of biotic or abiotic environmental stresses, and culminate in attacks, often lethal, by organisms of secondary action. Dieback, a common response to the effects of stress, reduces energy demands and serves as a survival mechanism. With abatement of stress, trees often recover if they have not been lethally invaded by organisms of secondary action. Control of dieback-decline diseases usually focuses on preventing or reducing effects of stress rather than on the mortality-causing organisms.

Houston, David R. **Characteristics of stands susceptible and resistant to gypsy moth defoliation**. In: Proceedings, forest-defoliator-host interactions: A comparison between gypsy moth and spruce budworms; 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983: 125.

Site conditions strongly influence where gypsy moth defoliation will occur. The often defoliated or susceptible forests characteristically grow on dry sites such as rocky ridges or deep sands. Resistant forests where defoliation is rare characteristically grow on relatively undisturbed sites with well-drained, deep loam soils where moisture is not limiting.

Houston, David R. **Developments in biological control of beech bark disease**. In: Proceedings, 10th international congress of plant protection 1983: Plant protection for human welfare; 1983 November 20-25; Brighton, England. Surrey, England: Forestry Commission; 1983: 1035-1041.

Beech bark disease results when bark of *Fagus* spp. is altered by the beech scale, and then invaded and killed by fungi of the genus *Nectris*. Potentially useful biological control factors or agents exist for both causal agents. The hosts, especially *F. grandifolia*, exhibit resistance to scale, and some bark epiphytes provide significant levels of protection against the insect. Less clear are the effects of several invertebrate predators and an entomogenous fungus often found in old scale colonies. *Nectria* spp. are parasitized by a mycoparasite, and other fungi are suspected competitors or antagonists. The significance of these microbial agents is under investigation.

Houston, David R. **Diebacks and declines of urban trees**. In: Proceedings, International symposium on urban horticulture; 1983 June; New York, NY. New York, NY: New York Botanical Garden, Institute of Urban Horticulture; 1983.

Houston, David R. **Diseases, insects, and forest diversity: Silvicultural implications**. In: Natural diversity in forest ecosystems: Proceedings of the workshop; 1982 November 20-December 1; Athens, GA. Athens, GA: University of Georgia; 1983: 235-249.

How diverse a forest is in species composition and structure may determine both its susceptibility and its vulnerability to diseases and insects. Usually, forests low in diversity suffer more serious losses than more diverse forests. But the effects are influenced by such attributes of the pest organisms as their host specificity, means of dissemination, and whether they cause mortality. Insects and diseases, especially those that kill trees, can influence forest diversity in many ways. Although it seems feasible to reduce losses to diseases and insects by regulating forest diversity through silviculture, few trials have been attempted, at least in the East. For many insects and diseases, genetic diversity offers promise that resistant trees can be selected and developed. But this process should be undertaken with the understanding that, because pests also possess intraspecific diversity, increases in host resistance may increase pest virulence.

Houston, David R.; O'Brien, James T. **Beech bark disease**. For. Insect & Dis. Leaflet 75. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983. 8 p.

Beech bark disease causes significant mortality and defect in American beech. The disease results when bark, attacked and altered by the beech scale is invaded and killed by fungi, primarily *Nectria coccinea* var. *faginata* Lohman, Watson, and Ayers, and sometimes *N. galligena* Bres.

Hoyle, M. C. **Automatic mat watering for containerized hardwood seedlings**. In: Thielges, Bart A., ed. Proceedings, 7th North American forest biology workshop; 1982 July 26-28; Lexington, KY. Lexington, KY: University of Kentucky; 1983: 281-286.

Hoyle, M. C. **Hydroponic rooting of birch: I. Solution, leaf age, and position effects.** In: Thielges, Bart A., ed. Proceedings, 7th North American forest biology workshop; 1982 July 26-28; Lexington, KY. Lexington, KY: University of Kentucky; 1983: 237-241.

Greenwood cuttings from paper birch seedlings were successfully rooted (95 percent) in dilute (10 percent full strength) Hoagland's solution #2 (H2). Rooting percentage in H2 was 3 to 4 times greater than in water. Branch cuttings rooted faster and to a higher percentage than stem cuttings. Leaf age was influential: Old leaves promoted rooting; young leaves inhibited rooting. American sweetgum rooted well in 10 percent H2 also.

Huyler, Neil K. **The economics of open-pan evaporators.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 79-82.

To evaluate the total annual cost of production fully, both noncash items, such as interest on capital and depreciation on building and equipment, and cash items, such as labor, fuel, electricity, taxes, insurance, and miscellaneous expenses, should be combined. The sum is the true total annual cost of production.

Huyler, Neil K. **Sap collection systems.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 71-78.

Discusses the economics of the plastic tubing system versus the bucket system, considering factors such as investment, depreciation, interest, operating expenses, taxes, and income.

Janerette, Carol A. **The influence of seedling age at the time of inoculation on mycorrhizae synthesis.** In: Proceedings, 5th North American conference on mycorrhizae; 1981 August 16-21; Quebec, PQ. Quebec, PQ: University of Laval; 1981. Abstract.

Janerette, Carol A. **In vitro development of sclerotia by *Pisolithus tinctorius*.** In: Proceedings, 5th North American conference on mycorrhizae; 1981 August 16-21; Quebec, PQ. Quebec, PQ: University of Laval; 1981. Abstract.

Jennings, D. T.; Houseweart, M. W. **Field attractiveness of (E)- and (Z)-11-tetradecenal pheromone blends to male spruce budworm moths, *Choristoneura fumiferana* (Clemens).** Journal of Chemical Ecology. 9(9): 1327-1332; 1983.

E:Z blends of (E)-11-tetradecenal were field tested (three experiments) for their attractiveness to male spruce budworm moths in northern Maine. Blends of 92.5 to 99 percent E isomer caught the most moths (three experiments); blend 95 percent E had the highest cumulative catch throughout two experiments. Rates of catch per hour for the four most attractive blends (92.5 to 99 percent E) showed highly variable responses among experiments; however, similarities were noted

for rates of catch within the same experiment. For all experiments and observation hours, blend 95 percent E had the highest mean rate of catch.

Jennings, Daniel T.; Crawford, Hewlette S. **Pine siskin preys on egg masses of the spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae).** The Canadian Entomologist. 115:439-440; 1983.

A male pine siskin consumed more than 2,100 eggs of the spruce budworm. The importance of bird predation on spruce budworm eggs is not known.

Jennings, Daniel T.; Hacker, Susanne C.; Knight, Fred B.; McKnight, Melvin E. **Spruce budworms bibliography.** Supplement 2. Misc. Rep. 268. Orono, ME: Maine Agricultural Experiment Station; 1982. 75 p.

Jennings, Daniel T.; Hacker, Susanne C.; Knight, Fred B.; McKnight, Melvin E. **Spruce budworms bibliography.** Supplement 3. Misc. Rep. 292. Orono, ME: Maine Agricultural Experiment Station; 1983. 59 p.

Jennings, Daniel T.; Houseweart, Mark W. **Parasitism of spruce budworm (Lepidoptera: Tortricidae) eggs by *Trichogramma minutum* and absence of overwintering parasitoids.** Environmental Entomology. 12: 535-540; 1983.

Egg masses of the spruce budworm were sampled in February and March for overwintering *Trichogramma minutum* Riley at five locations in central Maine. Egg mass densities and the percentage of parasitized eggs were generally greater in upper and middle crown levels than in the lower crown of balsam fir. Significantly more parasitized egg masses were "chewed" than partially parasitized or normal, eclosed egg masses. Parasitized eggs contained only cadavers of *T. minutum* pupae; thus, we found no evidence that this species or any other egg parasite overwinters in eggs of the spruce budworm.

Jennings, Daniel T.; Houseweart, Mark W. **Sticky-board trap for measuring dispersal of spruce budworm larvae.** Res. Pap. NE-526. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 7 p.

Describes a new sticky-board trap for measuring early-larval dispersal of the spruce budworm, and evaluates trap-board color and screened versus unscreened traps. Dispersing spruce budworm larvae showed no preference for trap color; fewer nontarget arthropods were caught on dark-colored than on light-colored traps. Screened traps caught significantly more spruce budworm larvae than unscreened traps, and they were easier to examine.

Jennings, Daniel T.; Houseweart, Mark W.; Dimond, John B. **Dispersal of losses of early-instar spruce budworm (Lepidoptera: Tortricidae) larvae in strip clearcut and dense spruce-fir forests of Maine.** Environmental Entomology. 12(6): 1787-1792; 1983.

Strip clearcutting contributed to dispersal losses of early-instar larvae of the spruce budworm. Significantly more L₁ larvae were trapped in uncut residual strips of strip clearcuts than in dense stands. Significantly more L₂ larvae were trapped in cut strips than in resid-

ual strips or in dense stands. Consistently more L₂ larvae were caught than L₁ larvae. Mean percentages of L₁ + L₂ larvae trapped represented small fractions (1.4-4.0%) of initial egg populations. Proportionately more larvae were trapped in strip clearcuts (uncut residuals + cut strips) than in dense stands. Estimated combined losses (L₁ + L₂) were 1.4 million larvae per hectare for dense stands and 2.9 million larvae per hectare for strip clearcuts.

Jennings, Daniel T.; Stevens, Robert E. **Southwestern pine tip moth.** For. Insect & Dis. Leaflet. 58.

Washington, DC: U.S. Department of Agriculture, Forest Service; 1982. 7 p.

Describes tree hosts, evidences of infestation, damage, life stages, life history, habits and control of the southwestern pine tip moth.

Jensen, K. F. **Growth relationships in silver maple seedlings fumigated with O₃ and SO₂.** Canadian Journal of Forest Research. 13(2): 298-302; 1983.

Growth analysis was used to measure the impact of low levels of ozone, alone and with sulfur dioxide, on the growth of silver maple seedlings. The seedlings were fumigated for up to 60 consecutive days with either 0.05, 0.1, or 0.2 ppm ozone, alone and with 0.1 ppm SO₂ for 12 hours per day. Dry weight and leaf area development curves were calculated from data collected at 10-day intervals throughout the study. Growth analysis variables were calculated from these curves.

Jensen, Keith F. **Air pollution and vegetative growth of forest trees.** In: Interaction between forest ecosystems and pollutants. Part I. Academy of Sciences of the Estonian Socialist Soviet Republic; Tallinn Botanical Gardens, Botanical Institute of the Academy of Sciences of The U.S.S.R., Tallinn; 1982: 127-131.

Jensen, Keith F. **Air pollution symptom and injury to shade trees.** In: Proceedings, Society of Municipal Arborists; 1982 October 6-7; Dayton, OH. publisher unknown; 1982: 6 p.

Air pollution, an important environmental stress factor, has received major attention only in the last two decades. Air-pollution problems have arisen because of man's accelerating appetite for energy to travel and to produce industrial goods. This energy is generated mainly by fossil fuel combustion, the combustion by-products being deposited into the atmosphere at a rate far greater than that at which they are removed by natural processes. As the pollutants accumulate in the atmosphere, they may reach concentrations that are harmful to growth processes in vegetation and, if the concentration becomes high enough, cause leaf necrosis or plant death.

Jensen, Keith F. **Atmospheric pollutants reduce the growth of yellow-poplar seedlings.** Misc. Publ. No. 162. Lexington, KY: Botanical Society of America. 1982: 69. Abstract.

One-year-old yellow-poplars were treated with clean air or with 0.1 ppm O₃ alone or in combination with either 0.2 ppm SO₂ or 0.2 ppm NO₂ for 12 or 24 hours per week for 20 weeks. Ten seedlings were harvested from each treatment at 4-week intervals to construct

growth curves. Significant differences were found among the curves for leaf area, leaf weight, stem plus leaf weight, and total seedling weight for seedlings in both treatments and for height growth in the seedlings fumigated 24 hours per week. Relative growth analysis parameters were calculated from the curves. Relative growth rate decreased with time and with all the fumigation treatments. Seedlings fumigated with ozone and NO₂ had the lowest relative growth rate.

Jensen, Keith F. **Effects of light, water and pollutant stresses on growth of yellow-poplar seedlings.**

Phytopathology. 73(5): 819; 1983.

One-year-old yellow-poplar seedlings were grown in outdoor chambers in either full sunlight or under 30 percent shade cloth. They were watered either daily, twice a week, or once a week. Seedlings from each of these six treatment combinations were exposed to one of four fumigation treatments: control, 0.1 ppm O₃, 0.2 ppm SO₂, or both 0.1 ppm O₃ and 0.2 ppm SO₂. Fumigations ran for 12 hours a day 2 days a week. Ten seedlings were harvested from each of the 24 treatment combinations at 4-week intervals to construct leaf area, leaf weight, and total seedling weight growth curves. Analysis of covariance showed significant differences among the growth curves for all three variables. Relative growth variables were calculated from the curves.

Jensen, Keith F. **Impact of ozone on yellow-poplar seedlings stressed with air pollutants.** American

Journal of Botany. 70(5): 86; 1983.

One-year-old yellow-poplar seedlings were stressed with air pollutants by fumigating them with either 0.05 ppm ozone, 0.1 ppm SO₂, or both 0.05 ppm ozone and 0.1 ppm SO₂ for 12 hours per day 7 days a week. The seedlings were then fumigated for 6 hours 1 day a week with 0.2 ppm ozone. The treatments lasted for 20 weeks. Eight seedlings were harvested from each treatment at 4-week intervals throughout the study. Growth response curves for height, leaf area, leaf weight, and total weight were developed and analyses of variance were performed on the data.

Ketchledge, E. H.; Leonard, R. E. **Ecological stability of Adirondack Mountain summit vegetation.**

Adirondack. 46 (10): 22-23; 1982.

Kingsley, Neal P. **Who owns Maine's woodlots?** In: Howlett, Duncan, ed. The small woodland owner in Maine: Proceedings of a symposium; 1982 March 24; Orono, ME. Orono, ME: University of Maine; 1982: 22-34.

Using the results of a national land ownership canvass conducted by the USDA Economic Research Service and the results of canvasses conducted by Northeastern Forest Experiment Station in other Northeastern States, we developed a picture of the ownership of Maine's woodlots. This picture shows two distinct ownership patterns in the state. In the north, ownership is predominantly industrial or associated with industry ownerships. In the south, the ownership pattern is more typical of the surrounding states. Ownership size and the attitudes of owners in this region are typical of those in New Hampshire.

- Kingsley, Neal P. **Private forests and recreation.** In: Proceedings, New England Section 63rd annual winter meeting: the future of forests in New England and Eastern Canada; 1983 March 9-11; Burlington, VT. SAF 83-05. Burlington, VT: New England Section, Society of American Foresters; 1983: 79-81.
- Discusses the results of the northeastern forest land-owner studies as they relate to recreational use of private lands. These studies show that 8.3 million acres in the Northeast are held primarily for recreation. This compares to only 7.6 million acres for timber production. Seventy-five percent of the private forest land in northern New England is available to the general public for some form of recreation compared with only 48 percent in southern New England. Most private owners do not prohibit all public use of their land but they do place restrictions and controls on that use.
- Knop, Nancy F.; Hoy, Marjorie A.; Montgomery, Michael E. **Altered hatch sequence of males and females from unchilled eggs of a "non-diapause" gypsy moth strain (Lepidoptera: Lymantriidae).** New York Entomological Society. 90(2): 82-86; 1982.
- Larvae hatching from unchilled egg masses of a "non-diapause" gypsy moth strain were reared to determine the hatch sequence of males and females. Males tended to hatch from non-diapause egg masses before females, which is the reverse of the hatching sequence of chilled wild egg masses. The reversed hatch sequence is not due to a skewed sex ratio or to differential mortality.
- Kochenderfer, J. N.; Wendel, G. W. **Effects of fertilization and aspect on leaf biomass, leaf size, and leaf area index in central Appalachian hardwood stands.** In: Muller, Robert, ed. Proceedings, 4th central hardwood forest conference; 1982 November 8-10; Lexington, KY. Lexington, KY: University of Kentucky; 1982: 102-112.
- Leaf biomass production and leaf area indexes were determined on four small hardwood-forested watersheds in West Virginia. Leaf area predictive equations were developed from leaf parameters for red and chestnut oak, red maple, and sugar maple. One of each watershed pair was fertilized with 336 kg nitrogen/ha and 224 kg phosphorous/ha. Leaf biomass production was not significantly related to fertilization or watershed aspect, but there was a significant difference among years. The best predictor of leaf area was the product of maximum width and maximum leaf length with R^2 values between 0.87 and 0.93. R^2 values for the correlation between leaf area and leaf weight ranged from 0.61 to 0.79.
- Kochenderfer, J. N.; Wendel, G. W. **Plant succession and hydrologic recovery on a deforested and herbicided watershed.** Forest Science. 29(3): 545-558; 1983.
- The recovery of a 60-acre watershed nearly barren of vegetation for several years with herbicides was monitored. Increases in water yield returned rapidly to pretreatment levels. Aboveground biomass increased as the woody vegetation became dominant, averaging 14.7 oven-dry tons per acre at the end of 10 growing seasons. There was a close relationship between biomass, height, percent ground cover, and increases in growing-season streamflow.
- Lamson, Neil I. **Precommercial thinning increases diameter growth of Appalachian hardwood stump sprouts.** Southern Journal of Applied Forestry. 7(2): 93-97; 1983.
- In West Virginia, crop trees were selected from 7- or 12-year-old yellow-poplar, basswood, red maple, black cherry, and northern red oak stump sprouts. Four treatments were evaluated: (1) control, (2) thinnings, (3) pruning, and (4) thinning plus pruning. Five years after treatment the diameter (d.b.h.) growth of thinned sprouts was 1.5 times greater than that of control sprouts. Pruning did not cause a significant decrease in 5-year d.b.h. growth. Height growth was not affected by the treatments. Most of the epicormic branches produced by pruning were dead 5 years after treatment. Natural pruning was reduced by thinning; the average clear bole length of thinned sprouts was about 2 feet shorter than that of the control sprouts. Survival was nearly 100 percent.
- Lamson, Neil I.; Miller, Gary W. **Logging damage to dominant and codominant residual stems in thinned West Virginia cherry-maple stands.** In: Muller, Robert, ed. Proceedings, 4th central hardwood forest conference; 1982 November 8-10; Lexington, KY. Lexington, KY: University of Kentucky; 1982: 32-38.
- Previously unmanaged 60-year-old, even-aged stands of cherry-maple in West Virginia were thinned using the Allegheny hardwoods stocking guide. A marked cut was computed for 75, 60, and 45 percent of full stocking; no trees smaller than 17.8 cm d.b.h. were marked for commercial removal. Thinning was done with either a truck-mounted crane or a rubber-tired skidder. In stands thinned with the truck-mounted crane, 4, 2, and 5 percent of the residual dominant and codominant trees (17.8 cm d.b.h. plus) were seriously abraded (with 650 cm² or more of exposed sapwood) in the 75, 60, and 45 percent treatments, respectively. In thinning with the skidder, 7, 13, and 22 percent of the residual dominant and codominant trees were seriously abraded in the 75, 60, and 45 percent treatments, respectively.
- LaPage, Wilbur F. **Five harmful marketing myths.** Woodall's Campground Management. 14(1): 10; 1982.
- The South African camping market is in an early stage of growth. Based on U.S. history, the South African campground industry may be able to avoid certain marketing problems. One must match the interests and needs of consumers with a "market place" of camping equipment and opportunities that is diverse, attractive, convenient, imaginative, priced realistically, and distributed properly.
- LaPage, Wilbur F. **Planning and research: forging a partnership for recreation's future.** In: Lieber, Stanley R.; Fesenmaier, Daniel R., eds. Recreation planning and management. State College, PA: Venture Publishing; 1983: 376-381.
- LaPage, Wilbur F. **Recreation resource management for visitor satisfaction.** In: Lieber, Stanley R.; Fesenmaier, Daniel R., eds. Recreation planning and management. State College, PA: Venture Publishing; 1983: 279-285.

Recreation managers must not confuse quality and style. A high-quality recreation experience is one which meets or exceeds visitor expectations; this includes managerial interaction with visitors and maintaining specified management standards. A satisfaction monitoring system that is easy and inexpensive to administer is described.

Lautenschlager, R. A.; Crawford, H. S. **Halter-training moose.** Wildlife Society Bulletin. 11(2): 187-189; 1983.

The use of "tamed" wild animals for food habit studies has increased during the last 3 decades. This technique has been used with a variety of wild ungulates. Describes a technique for halter-training moose for food habit studies.

Lawson, H. Randy; Yost, Larry A.; Jennings, Daniel T. **Southwestern pine tip moth: notes on larval descent behavior, predators, and associated shoot borer in northern Arizona.** Southwestern Naturalist. 28: 95-97; 1983.

Mature larvae of the southwestern pine tip moth descend host tree boles between 0400 and 0700 hours. Several ant species, a spider, and a syrphid larva were observed feeding on tip moth larvae; the snakefly accepted larvae as prey in feeding tests. Young ponderosa pines are susceptible to concurrent infestations by the tip moth and the western pine-shoot borer. Infestation rates were 58 percent for *E. sonomana*, 73 percent for *R. neomexicana*, and 34 percent for both. The shoot borer prefers larger trees; the tip moth prefers smaller trees.

Leak, W. B. **Maintaining quality growth.** In: Proceedings, hardwood forest management and utilization symposium; 1982 October 25-26; Orono, ME. Misc. Rep. 279. Orono, ME: University of Maine, Maine Agricultural Experiment Station; 1983: 10-12.

Maintenance of quality growth in hardwood stands depends upon maintenance of: (1) desirable species composition, (2) tree form, and (3) high growth rates per acre and per tree.

Leak, W. B.; Tubbs, C. H. **Percent crown cover tables for applying the shelterwood system in New England.** Res. Note NE-313. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p.

Provides tables for estimating residual percent crown cover, using a 10-factor prism, of three species groups: (1) sugar and red maples, yellow and paper birches; (2) white ash, white pine, red spruce, balsam fir, and hemlock; and (3) beech.

Leak, William B. **Stocking, growth, and habitat relations in New Hampshire hardwoods.** Res. Pap. NE-523. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

Data from hardwood stands in New Hampshire substantiated the crown-width relationships used to develop the B-line (based on circular crowns) in the 1969 northern hardwood stocking guide, and produced an A-line slightly lower than the original line. Position of the A-line was unrelated to site or forest type.

Diameter growth of hardwoods on moist and dry soils declined rapidly with increasing tree diameter. On fine till, diameter growth was nearly constant over tree diameter but positively related to relative crown size. Based on diameter-growth regressions, calculations of stand growth indicated that the minimum basal area for adequate even-aged stand growth was quite low (30 to 60 square feet) and roughly constant over mean stand diameter.

Leonard, R. E.; McBride, J. M.; Conkling, P. W.; McMahon, J. L. **Ground cover changes resulting from low-level camping stress on a remote site.** Res. Pap. NE-530. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p.

Reports the effects of low-level camping stress on vegetation in a remote site. South Big Garden Island in Penobscot Bay, Maine, was studied because (1) it had no prior recreational use; thus, comprehensive base line data could be obtained; and (2) the exact number of campers could be monitored throughout the study period. The continuous line-intercept method based on a single vegetation transect line was developed to monitor vegetation and ground cover changes over a 2-year period. The low-level use (an average of 50 campers/year) that was recorded did not significantly reduce the total vegetation cover but did have an effect on species composition.

Lewis, F. B. **Deposit assessment techniques for Bt.** Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; CANUSA Data Fact Sheet, 1982 May. 2 p.

Lewis, Franklin B. **Biological insecticides.** In: Proceedings, Southern conference on the gypsy moth; 1982 September 14-15; Crossmore, NC. Raleigh, NC: State of North Carolina Department of Agriculture; 1982: 58-59.

Lewis, Franklin B. **Comparison of spray tower applications of VIRIN-ENSh and GYPCHK.** In: Ignoffo, Carlo M.; Martignoni, Mauro E.; Vaughn, James L., eds. A comparison of the U.S. (GYPCHK) and USSR (VIRIN-ENSh) preparations of the nuclear polyhedrosis virus of the gypsy moth, *Lymantria dispar*: Results of research conducted under Project V-01.0705, microbiological control of insect pests, of the US/USSR joint working group on the production of substances by microbiological means. Washington, DC: American Society for Microbiology; 1983: 50-55.

In spray tower tests, the original sample of VIRIN-ENSh had lower activity than expected at the poly-inclusion-body dose tested, compared to the same GYPCHK dosages. The activity of VIRIN-ENSh increased substantially after one passage through a U.S. strain of gypsy moth and was comparable to GYPCHK. Although hemolytic *Bacillus* was present, the VIRIN-ENSh sample did not contain coliforms nor vertebrate pathogens and was not toxic nor pathogenic to mice.

Lewis, Franklin B. **Comparison of spray tower applications of VIRIN-ENSh and GYPCHK.** In: Ignoffo, Carlo M.; Martignoni, Mauro E.; Vaughn, James L.,

- eds. A comparison of the U.S. (GYPCHEK) and USSR (VIRIN ENSH) preparations of the nuclear polyhedrosis virus of the gypsy moth, *Lymantria dispar*: Results of research conducted under Project V-01.0705, microbiological control of insect pests, of the US/USSR joint working group on the production of substances by microbiological means. Washington, DC: American Society for Microbiology; 1983: 9. Abstract.
- See previous entry.
- Lewis, Franklin B. **Gypsy moth NPV research—Hamden.** In: Proceedings, 1982 National Gypsy Moth Review; 1982 December 7-9; Harrisburg, PA. Middletown, PA: Pennsylvania Department of Environmental Resour.; 1983: 124-125.
- Reports major findings on gypsy moth nucleopolyhedrosis (NPV) research at the Hamden Center for Biological Control of Northeastern Forest Insects and Diseases. Major activities are centered around formulation-application-processing work, nonconventional (nonaerial) use of NPV, and internal transmission of NPV, detection, and modelling of natural and applied NPV.
- Likens, G. E.; Bormann, F. H.; Pierce, R. S.; Munn, R. E. **Long-term trends in precipitation chemistry at Hubbard Brook, New Hampshire.** In: 1st international conference of the Commission on Atmospheric Chemistry and Global Pollution (CACGP); Symposium on tropospheric chemistry; 1983 August/September; Oxford, England. [Place of publication unknown]; [Publisher's name unknown]; 1983. Abstract.
- Little, Robert L.; Holtzclaw, Randall D.; Martens, David. **Computer simulation of pallet production—how can it help me?** Pallet Enterprise. 2(6): 25-27; 1983.
- Little, W. **Varying effects of fires in the New Jersey Pine Barrens.** In: Good, Ralph. Ecological solutions to environmental management concerns in the Pine-lands National Reserve: Proceedings of a conference; 1982 April 18-21; Camden/Cherry Hill, NJ. New Brunswick, NJ: Rutgers University; 1982: 11-16.
- Luppold, William G. **An economic analysis of the hardwood lumber market.** In: America's hardwood forests—opportunities unlimited. Proceedings, 1982 convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American Foresters; 1983: 248-253.
- This economic analysis attempts to isolate and quantify the factors that affect the market. The findings indicate that market fluctuations are internally generated by demanders reacting to current price. The activity of the general economy also contributes to market fluctuations which create uncertainty and limit growth. High interest and wage rates also have limited demand growth. Wage rates and stumpage price have increased production cost of suppliers, while the increases in exports have contributed to the rapid price increases in the late 1970's.
- Luppold, William G. **The effect of changes in lumber and furniture prices on wood furniture manufacturers' lumber usage.** Res. Pap. NE-514. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.
- Wood furniture manufacturers' demands for oak, maple, poplar, open-grain, close-grain, and all species of lumber were developed using cross-sectional, time-series estimation techniques.
- Luppold, William G. **How lumber and furniture prices affect furniture manufacturers' wood usage.** Southern Lumberman. 244(3039): 70-71; 1983.
- Wood furniture manufacturers' demands for oak, maple, poplar, open-grain, and close-grain lumber are estimated using cross-sectional, time series techniques. The analyses indicate that the demand for open-grain species is more price responsive than the demand for close-grain species. The calculated cross-price elasticities indicate that furniture producers do substitute species through style decisions. However, poplar lumber has a negative cross-price elasticity, indicating that it is used with, rather than substituted for, other species.
- Lynch, James A.; Corbett, E. S. **Atmospheric deposition: Milford, Pennsylvania.** LW8308. University Park, PA: Institute for Research on Land and Water Resources; 1983. 72 p.
- Lynch, James A.; Corbett, Edward S. **Atmospheric deposition: spatial and temporal variation in Pennsylvania 1982.** LW8313. University Park, PA: Institute for Research on Land and Water Resources; 1983. 73 p.
- Lynch, James A.; Corbett, Edward S. **Atmospheric deposition: spatial and temporal variation in Pennsylvania 1982.** LW8313A. University Park, PA: Institute for Research on Land and Water Resources; 1983. 204 p.
- Lynch, James A.; Corbett, Edward S. **Relationship of antecedent flow rate to storm hydrograph components.** In: International symposium on hydrometeorology; 1982 June 13-17; Denver, CO. Bethesda, MD: American Water Resources Association; 1983: 73-77.
- The importance of antecedent flow rate (AFR) as an index of soil moisture conditions on a forested watershed was quantitatively evaluated, and relationships between AFR and individual storm hydrograph components were developed. The relationship between AFR and antecedent soil moisture (ASM) was also obtained.
- Lynch, James A.; Corbett, Edward S.; Hanna, C. **Predicting fluctuations in non-point source pollution from forested watersheds during episodic events.** LW8302. University Park, PA: Institute for Research on Land and Water Resources; 1983. 100 p.
- McBride, J. C.; Leonard, R. E. **A system for measuring ground cover changes.** Parks. 7(3): 20; 1982.
- Describes a "quadropod" frame that positions a camera to record groundcover changes in 1- x 1.5-meter plots.

McDaniel, Ivan N.; Jennings, Daniel T. ***Loxosceles reclusa* (Araneae: Loxoscelidae) found in Maine, USA.** *Journal of Medical Entomology*. 20(3): 316-317; 1983.

During June 1981 a male and female *Loxosceles reclusa* were found in Maine, USA. Both spiders were probably transported to Maine during midwinter by a family who moved there from Oklahoma. Introduction of female spiders into domestic habitats could potentially establish breeding colonies well beyond the known natural range of *L. reclusa*. Numerous alleged spider-bite cases have recently been reported in Maine; however, no *L. reclusa* has been directly associated with these bites.

McKeever, David B.; Martens, David G. **Wood used in U.S. manufacturing industries, 1977.** *Resour. Bull. FPL-12*. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1983; 32 p.

This study was based on a survey of wood products used by manufacturers in 1977. It found that manufacturers consumed 16.4 billion board feet of lumber, 0.9 billion board feet of logs and bolts, 4.1 billion square feet (3/8-in. basis) of plywood and veneer, 2.1 billion square feet (1/8-in. basis) of hardboard, 0.7 billion square feet (1/2-in. basis) of particleboard and medium-density fiberboard.

McManus, M. L.; Mason, C. J. **Determination of the settling velocity and its significance to larval dispersal of the gypsy moth (Lepidoptera: Lymantriidae).** *Environmental Entomology*. 12(1): 270-272; 1983.

The settling velocity of newly hatched gypsy moth 1st instars was determined to range from 41 to 117 cm/sec. Settling velocity is proportional to the weight of the unfed larvae, and is modified by attached silk. A 90-cm length of silk causes a 30 to 50 percent reduction in the settling velocity of larvae. The role of settling velocity in the passive dispersal of gypsy moth larvae is discussed in the context of current theories that relate the dispersability of larvae to qualitative differences among populations.

Marquis, D. A. **Ecological and historical background: Northern hardwoods.** In: Finley, J.; Cochran, R. S.; Grace, J. R., eds. *Regenerating hardwood stands: Proceedings of a symposium*; 1983 March 15-16; University Park, PA. University Park, PA: The Pennsylvania State University; 1983: 9-29.

The present northern hardwood—or Allegheny hardwood—forest type in Pennsylvania originated after a long period of partial cuttings in the 1800's, followed by extensive clearcuttings at the turn of the century. The history of this period of forest cutting is traced and related to the age arrangement, structure, and species composition of present stands.

Marquis, D. A. **Management strategies for successful regeneration: Northern hardwoods.** In: Finley, J.; Cochran, R. S.; Grace, J. R., eds. *Regenerating hardwood stands: Proceedings of a symposium*; 1983 March 15-16; University Park, PA. University Park, PA: The Pennsylvania State University; 1983: 214-238.

Factors important to regeneration in the northern hardwood forest type of Pennsylvania are summarized, and a systematic procedure for determination of the most appropriate regeneration practices in particular stands is described. Conditions suitable for both all-age and even-age management are considered, and silvicultural procedures including clearcutting, shelterwood cutting, herbicide application fertilization, fencing, and planting are all described.

Marquis, David A. **Regeneration of black cherry in the Alleghenies.** In: *Proceedings, 11th annual hardwood symposium of the Hardwood Research Council*; 1983 May 10-13; Cashiers, NC. Asheville, NC: Hardwood Research Council; 1983: 106-119.

Regeneration of new hardwood stands containing a desirable mixture of fast-growing, high-value species such as black cherry is made exceptionally difficult in the Alleghenies by excessive browsing by deer, allelopathic interference by understory ferns, inadequate seed production, and inadequate advance seedlings. A series of studies on the germination, survival, and growth of key species has led to a series of regeneration guidelines providing for clearcutting, shelterwood cutting, and herbicide treatment of the understory with the appropriate combination depending upon the particular stand condition present.

Marquis, David A.; Gearhart, Porter. **Cherry - Maple.** In: *Silvicultural systems for the major forest types of the United States*. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 137-140.

Martens, David G. **Pallet mill residues in demand.** *Pallet Enterprise*. 2(6): 14; 1983.

Martin, A. Jeff. **Optimum tree size for products having a maximum scaling diameter.** *Journal of Forestry*. 81(7): 438-439; 1983.

Although most primary forest products have only minimum size requirements, some have a maximum limitation as well. For products with a maximum scaling diameter, it was found that optimum tree diameter at breast height (the diameter class with the most product volume per tree) could be easily predicted by using only the maximum scaling diameter and product length. A prediction equation and an optimum-d.b.h. table based on this equation are presented.

Martin, A. Jeff. **The taper equation: A multi-purpose tool for the forester.** *The Consultant*. 28(2): 42-45; 1983.

The use of a taper equation for estimating stem diameters (inside and outside bark) for given heights, heights to specified diameters, and volumes between any two points on the bole is described. Coefficients are presented for 18 eastern hardwood species. Computations are relatively simple; most hand-held calculators can do them. A computer program that uses the equation for preparing a variety of volume tables is available.

Mathews, Nancy E.; Porter, William F.; Brooks, Robert T. **Assessments of nongame habitat using Forest Service resources evaluation: A regional perspective.** In: Yahner, Richard H., ed. *Transactions of*

- the Northeast Section, The Wildlife Society: 40th Northeast Fish and Wildlife Conference; 1983 May 15-18; West Dover, VT. Publisher unknown ; 1983: 173. Poster session abstract.
- Federal legislation enacted during the 1970's mandates comprehensive management planning and assessments of renewable resources. Wildlife habitat is identified as one such renewable resource. The USDA Forest Service is attempting to integrate measures of wildlife habitat into its regional assessments of forest resources. In the Northeast, resource evaluation has been expanded to include measurements of both wildlife habitat and timber oriented variables.
- Hielke, Manfred E.; Haynes, Clark; Rexrode, Charles O. **Local spread of oak wilt in northwestern West Virginia during 1970-1982.** *Plant Disease*. 67(11): 1222-1223; 1983.
- In 1982, 41 oak wilt centers originally found in 1970-73 in northeastern West Virginia were revisited to determine the presence of oak wilt and the increase in oak mortality since the time of discovery. Fourteen centers had no dead or wilting trees. Ten centers had wilting trees, and 27 had dead or dying trees within 15.2 m of the tree that died first on the site. Neither cactinyl acid injections nor deep girdling in 1970-73 affected the subsequent incidence of mortality compared with no treatment. The average rate of increase in the 27 centers showing symptoms of oak wilt was 0.39 newly diseased trees per center per year. Total basal area per hectare was affected little by oak wilt.
- Hielke, Manfred E.; Houston, David R. **Beech bark disease in West Virginia: Status and impact on the Monongahela National Forest.** In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 8; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 27-30.
- Cryptococcus fagisuga* has infested over 70,000 acres of forest in West Virginia. Beech bark disease is causing heavy mortality in two areas of the Monongahela National Forest and additional scattered mortality. In the areas most affected, per-acre losses total 1,369 board feet of sawtimber and 2.67 cords, with a potential loss of 5,697 board feet and 9.29 cords. *Nectria galligena* seems to be the only species of *Nectria* involved in the disease complex.
- Montgomery, Michael E. **Biomass and nitrogen budgets during larval development of *Lymantria dispar* and *Choristoneura fumiferana*: allometric relationships.** In: Proceedings, forest-defoliator—host interactions: A comparison between gypsy moth and spruce budworms; 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983: 133-140.
- Spruce budworm larvae had a higher relative growth rate (RGR), biomass conversion efficiency (ECI), and nitrogen utilization efficiency (NUE) than gypsy moth larvae. As both species matured, relative rates of growth and consumption and conversion efficiencies declined. The decline in rates with maturation are allometric (related to body size) and can be expressed as $y = aX^b$, where y is the rate and X is the size of the animal.
- Montgomery, Michael E. **Foliage chemistry of oaks growing on sites resistant or susceptible to gypsy moth defoliation.** In: Parker, Bruce L.; Hanson, Patricia M.; Teillon, H. Brenton, eds. Proceedings, 15th annual Northeastern forest insect work conference; 1982 March 11; Portland, ME. MP 108. Burlington, VT: University of Vermont Agricultural Experiment Station; 1983: 1. Abstract.
- Compares chemistry of and gypsy moth performance on foliage from *Quercus rubra* and *Q. prinus* growing on either susceptible or resistant sites. Foliage chemistry as an explanation for site susceptibility supplements other causal factors such as structural features.
- Montgomery, Michael E.; Wargo, Philip M. **Ethanol and other host-derived volatiles as attractants to beetles that bore into hardwoods.** *Journal of Chemical Ecology*. 9(2): 181-190; 1983.
- Ethanol, methanol, acetone, and acetaldehyde—chemicals identified in the inner bark of living trees—were used to bait bane traps placed in crowns of oak trees in Connecticut. Ethanol-baited traps caught more cerambycid, scolytid, and clerid beetles than unbaited traps. Buprestidae were not attracted to ethanol. Acetaldehyde and acetone were not attractive to any family. A mixture of ethanol, methanol, and acetaldehyde was no more attractive than ethanol alone. The bane traps were very effective at catching Cerambycidae and Scolytidae, but ineffective compared to sticky panels at catching Buprestidae.
- More, Thomas A. **The nonusers of an urban forest interpretative center.** *Journal of Interpretation*. 8(1): 1-9; 1983.
- Users and nonusers of an interpretive museum in a 650-acre day-use recreation area were compared in terms of their social characteristics and motives for visiting the area. Visitors came to the area seeking esthetic and educational experiences in the company of family or friends. Fifty-four percent visited the interpretive center. Although there were no differences between users and nonusers in terms of motive profiles, the likelihood of a person's visiting the center was affected by age, number in party, and the number of prior visits to the area. Understanding why some people are not interested in the interpretive effort is essential if interpreters are to broaden the scope of the audience.
- More, Thomas A.; Stevens, Thomas H.; Allen, P. Geoffrey. **Economic valuation of urban open-space resources.** In: America's hardwood forests—opportunities unlimited. Proceedings, 1982 convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American Foresters; 1983: 336-339.
- We conducted a benefit/cost analysis of four urban parks in Worcester, Massachusetts. The results showed that these 219 acres of urban open space produce an estimated \$560,320 of benefits annually for the citizens of Worcester. This exceeds the annual operating cost by a ratio of 4.48 to 1. Further research is needed to determine precisely how different park attributes affect the value of both external and on-site benefits.

Morse, M. F.; Whalen, M. L.; Baggett, K. L.; Sendak, P. E. **Quality of syrup produced from sap concentrated by reverse osmosis (RO).** *Maple Syrup Journal*. 1982 June: 18.

Munn, R. E.; Likens, G. E.; Weisman, B.; Hornbeck, J. W.; Martin, C. W.; Bormann, F. H. **A meteorological analysis of the precipitation chemistry event samples at Hubbard Brook, New Hampshire.** In: 1st international conference of the Commission on Atmospheric Chemistry and Global Pollution (CACGP); Symposium on tropospheric chemistry; 1983 August/September; Oxford, England. [Place of publication unknown]: [Publisher's name unknown]; 1983. Abstract.

Nevel, Robert L., Jr. **Veneer, 1980—A periodic assessment of regional timber output.** *Resour. Bull. NE-77*. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 17 p.

Evaluates regional timber output based on a canvass of the veneer plants in the Northeast and contains statistics for 1980 on the veneer-log production and receipts by states and species, log shipments between states and regions, and the disposition of manufacturing residues. Between 1976 and 1980, veneer log production jumped 19 percent and northeastern veneer plant receipts dropped slightly. Trends in production and an outlook for the industry are presented along with a list and map of veneer plants in the Northeast.

Nevel, Robert L., Jr.; Blyth, James E. **Veneer log production in the Northeastern and North Central States in 1980.** *Northern Logger*. 31(11): 40-41; 1983.

Twenty of the twenty-one Northeastern and North Central States produced a total of 242.8 million board feet of veneer logs in 1980, up 6 percent from 1976. Four-fifths of the logs harvested in the area came from seven states. Active veneer mills declined from 96 in 1976 to 86 in 1980. In the Northeast, 36 mills used 120.5 million board feet of veneer logs. The 50 mills in the North Central states consumed 91.7 million board feet. Total receipts of veneer logs for the 21-state area dropped by 6 percent since 1976.

Nik, Abdul Rahim Hj; Lee, Richard; Helvey, J. David. **Climatological watershed calibration.** *Water Resources Bulletin*. 19(1): 47-50; 1983.

This study tests the hypothesis that climatic data can be used to develop a watershed model so that stream flow changes following forest harvest can be determined.

Noble, Reginald D.; Jensen, Keith F. **An apparatus for monitoring CO₂ exchange rates in plants during SO₂ and O₃ fumigation.** *Journal of Experimental Botany*. 34(141): 470-475; 1983.

An apparatus is described for measuring photosynthetic carbon dioxide assimilation, dark respiration, photorespiration and the CO₂ compensation point by plant materials fumigated with sulphur dioxide and/or ozone. This system uses an infrared gas analyser (IRGA) in a closed-loop system. Sulphur dioxide is added from permeation tubes, and O₃ is generated by ultraviolet light.

Regulation of fumigant concentration and scrubbing the fumigants from the system are described.

Northeastern Forest Experiment Station. **Forest research—Berea, Kentucky.** NE-INF-55-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 12 p.

Describes the country's most comprehensive research effort on surface-mine reclamation at the Northeastern Forest Experiment Station's Laboratory at Berea, Kentucky. Scientists at Berea are developing practical and cost-efficient methods to reduce damage to the environment and forest resources from surface mining, and to reclaim newly mined and abandoned mined areas for the benefit or enhancement of water quality, timber, wildlife, recreation, range, and esthetic values.

Northeastern Forest Experiment Station. **Progress in forestry research in the Northeast, 1980-1981.** Gen. Tech. Rep. NE-81. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 56 p.

A summary report on highlights of research activities and accomplishments of the Northeastern Forest Experiment Station in 1980-81, including an annotated list of publications.

Northeastern Forest Experiment Station. **Progress in forest research in the Northeast—1982.** Gen. Tech. Rep. NE-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 31 p.

A summary report on highlights of research activities and accomplishments of the Northeastern Forest Experiment Station in 1982, including an annotated list of publications.

Nyland, Ralph D.; Marquis, David A.; Whittemore, Donald K. **Northern hardwoods.** In: Choices in silviculture for Eastern Canadian forests. Fredricton, NB: Forest Extension Branch, New Brunswick Department of Natural Resources; 1982: 17-22.

Silvicultural options in the northern hardwood forests of Eastern Canada are described in nontechnical terms to help landowners understand how these forests are best managed for timber production, recreation and wildlife use, and watershed protection.

Nyland, Ralph D.; Marquis, David A.; Whittemore, Donald K. **Peuillus du Nord.** In: Les choix de sylviculture dans les forêts de L'est Canadien. Fredricton, NB: Le Service de Consultation Forestière; Ministère des Ressources Naturelles du Nouveau-Brunswick; 1983: 21-27.

French translation of "Northern hardwoods" in *Choices in silviculture for American forests*; Washington, DC: Society of American Foresters; 1981.

ODell, T. M.; Mastro, V. C. **Management of sparse gypsy moth populations by using the sterile-male technique.** In: Proceedings, 1982 national gypsy moth review; 1982 December 7-9; Harrisburg, PA. Middletown, PA: Pennsylvania Department of Environmental Resources; 1983: 126-135.

The 5-year gypsy moth sterile male program involving Forest Service, APHIS, and ARS scientists is reviewed. The release of sterile males in Benton Harbor, Michigan, reduced the population below a detectable level. A pilot project to demonstrate the inherited sterility technique is described.

Dell, Thomas M. **Monitoring and assessment of gypsy moth populations: A requirement for effective pest management decisions.** Connecticut Timber Trends. 4(2): 4-5, 8; 1983.

Olsen, Eldon D.; LeDoux, Chris B.; McIntire, John C. **Determining deck size limitations for small cable yarders.** In: Logger's Handbook. Vol. 43. Edmonds, WA: Timber/West Publications, Inc.; 1983: 11-12, 50.

Patton, Roy L. Garraway, Michael O. **Cell wall and photoplast peroxidase activities in leaves of two hybrid poplar clones that differ in susceptibility to ozone injury.** Phytopathology. 73(5): 820; 1983. Abstract.

Peters, Penn A.; Biller, Cleveland J. **Log attachment methods evaluated by a Latin square design.** In: Proceedings, 1982 winter meeting American Society of Agricultural Engineers; 1982 December 14-17; Chicago, IL. St. Joseph, MI: American Society of Agricultural Engineers; 1983: Paper No. 82-1604.

A Latin square design was used to test the effect of log attachment method on mainline force required to move hardwood logs uphill. The effect of log attachment method was insignificant. Log weight was a simple linear predictor for mainline force accounting for 66 percent of the variation.

Peterson, Jeffrey M.; Rice, William W.; Gatchell, Charles J. **Factors affecting energy self-sufficiency for a System 6 sawmill.** Res. Bull. No. 685. Amherst, MA: Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst; 1983. 32 p.

Phillips, Ross A. **Skidder load capacity and fuel consumption HP-41C program.** Res. Pap. NE-537. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 7 p.

Program gives log weight that the skidder can move and gives fuel consumption either in liters or gallons per turn. Slope of the skid trail, skidder weight, and skid distance must be entered into the program.

Podgwaite, J. D.; Bruen, R. B.; Shapiro, M. **Microorganisms associated with production lots of the nucleopolyhedrosis virus of the gypsy moth, *Lymantria dispar* [Lep.: Lymantriidae].** Entomophaga. 28(1): 9-16; 1983.

Samples of a gypsy moth nucleopolyhedrosis virus product, Gypchek[®], were taken each day during a 100-day production run and monitored for the presence of pathogenic bacteria and fungi. We did not detect obligate anaerobic or fecal coliform bacteria in any of the samples. *Bacillus cereus*, *Staphylococcus epidermidis*, *B.licheniformis*, *Streptococcus faecalis*, *Serratia lique-*

faciens, and *Aspergillus niger* were the most frequently isolated microorganisms. We did not detect primary pathogenic bacteria or fungi, but the presence of opportunistic pathogens indicated that assiduous monitoring of the virus production facility and rigorous quality control of production batches are necessary.

Porter, William F.; Mathews, Nancy E.; Doyle, Terrence J.; Brooks, Robert T. **The U.S. Forest Service inventory: An approach for assessing wildlife habitat.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 628-631.

Studies initiated in 1980 to investigate the capabilities of the Forest Inventory and Analysis survey (FIA) of the USDA Forest Service for assessing wildlife habitat involved a comparison of the faunal community with vegetative and physiographic characteristics of forest stands sampled by the USDA Forest Service survey. Population indices for 25 species of songbirds and small mammals, obtained during the summer of 1981 on 82 and 34 FIA plots, respectively, in central New York State, were compared with FIA data collected on the same plots by the Forest Service in 1978-79. Statistical methodology is presented, with some preliminary results and recommendations for future investigations.

Powell, Douglas S.; Cost, Noel D. **Differentiating real resource change from other concurrent inventory differences.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 541-545.

When estimating change that has occurred between periodic resource inventories, extraneous changes in the estimates should be identified and isolated or minimized. Besides changes in sampling techniques and normal error, such extraneous inventory differences may result from changes in definitions, data collection procedures, or data processing techniques. Specific examples illustrate the impact that such inventory differences have on real resource change.

Rafaill, Barbara L. **Establishment of trees on artificially revegetated and abandoned surface mines.** In: Pope, P. E., ed. Proceedings, 3rd annual better reclamation with trees conference; 1983 June 2-3; Terre Haute, IN. West Lafayette, IN: Purdue University, Department of Forestry and Natural Resources; 1983: p. 89. Abstract.

Rast, Everette D. **Proportion of northern red oak veneer logs processed into veneer and byproducts in a half-round slicing operation.** Forest Products Journal. 33(11/12): 54-56; 1983.

The proportion of northern red oak veneer logs processed into slabs and sawdust, backing boards, spurred residue, round-up residue, and veneer in a half-round slicing operation was determined. Overall, 54 percent of the total bark-free log volume is converted into veneer. Slabs and backing boards make up 33 percent of the residue. The relationship between butt and upper

log, the effect of diameter, and log overlengths are discussed. The data base will allow mill managers who monitor production at each phase of the operation to determine operating efficiency.

Reeves, R. Marcel; Dunn, Gary A.; Jennings, Daniel T. **Carabid beetles (Coleoptera: Carabidae) associated with the spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae).** The Canadian Entomologist. 115: 453-472; 1983.

Barrier-pitfall traps and tree bands were used to sample adult carabid beetles in five forest stands of different tree species composition and spruce budworm infestation levels. Twenty genera and thirty-seven species were collected over the 2-year period. Adult carabid populations were highest in the red spruce stand, while carabid species diversity was greater in hardwood and fir stands having the most tree species diversity. Potential adult carabid predators of spruce budworm were identified.

Rexrode, C. O. **Gum spots in black cherry.** Northern Logger. 32(5): 14-15, 24; 1983.

Discusses what gum spots are in black cherry and what agents cause them. Also, discusses the importance of gum spots and how they degrade black cherry. Insects are the primary cause of gum spots in black cherry. Bark beetles cause the most gum spots in both poletimber and sawtimber black cherry. Gum spots cause the most degrade in veneer, veneer logs, and factory grade sawlogs.

Rexrode, Charles O. **Yellow-bellied sapsuckers can damage valuable black cherry trees.** Pennsylvania Farmer. 208(9): 35; 1983.

The yellow-bellied sapsucker attacks black cherry and degrades the wood. Sapsucker-caused gum spots and their effects on the quality of black cherry are discussed and illustrated.

Rexrode, Charles O.; Baumgras, John E. **Preliminary study on decay in second-growth black cherry in West Virginia.** W. Va. For. Notes Circ. Morgantown, WV: West Virginia University, Agricultural and Forestry Experiment Station; 1983; 123(10): 1-2.

Decay was present in 80 percent of 63 poletimber trees and 62 percent of 53 sawtimber trees. However, 73 percent of the sample discs had no decay, and 34 percent had 5.0 cm² or less. Most decay gained entry through branch stubs and was confined to overgrown knots that resulted from dead branch stubs.

Rexrode, Charles O.; Brown, H. Daniel. **Oak wilt.** For. Insect & Dis. Leaflet. 29. Washington, DC: U.S. Department of Agriculture; 1983. 6 p.

Oak wilt, caused by the fungus *Ceratocystis fagacearum* (Bretz) Hunt kills oak trees. It has been found in 21 states, with considerable damage occurring in the Midwest. In West Virginia where predominately oak forests cover 70 percent of the land area, oak wilt losses average less than one tree per square mile each year. Oak wilt has also been reported in Texas—outside its main range. No species of oak is known to be immune to this vascular disease.

Reynolds, Hugh W. **When times are good again for furniture and kitchen cabinet makers.** NE-INF-51-83.

Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 4 p.

During good times, high-quality hardwood lumber prices rise rapidly. During poor times, these prices fall and then rise slowly. We are presently, 1980 to present, in a poor time's situation. The need for an alternate source of parts when good times come again is discussed.

Reynolds, Hugh W.; Araman, Philip A. **System 6: making frame-quality blanks from white oak thinnings.**

Res. Pap. NE-520. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 9 p.

Low-grade white oak timber, removed during a timber stand improvement cut on the Jefferson National Forest in Virginia, was made into sawlogs, poles, 6-foot bolts, 4-foot bolts, pulpwood, and firewood. The 6-foot bolts were sawed to two cants per bolt; cants were resawed to 4/4 System 6 boards; boards were dried to 6 percent moisture content and were then made into frame blanks using System 6 technology. The blanks were used by an upholstered furniture company to make frames and were found very satisfactory. Yields of required frame blanks were good, 56 percent, when only the poorest two-thirds of all boards were used. The better boards can be used to make clear-quality blanks.

Reynolds, Hugh W.; Araman, Philip A.; Gatchell, Charles J.; Hansen, Bruce G. **System 6 used to make kitchen cabinet C2F blanks from small-diameter, low-grade red oak.** Res. Pap. NE-525. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

Hardwood dimension manufacturers can make profitable use of plentiful small-diameter, low-grade timber when System 6 technology is used. We describe a System 6 plant designed to make clear-two-face (C2F) blanks for the kitchen cabinet industry. Data for plant operation are taken from a study in which red oak bolts (from a reforestation clearcut) were used to make 33-, 29-, 25-, 21-, and 15-inch-long standard-size blanks. Serpentine end matching of short pieces was used to increase the quantity of 25-inch blanks. The economics of two options for plant operation is explained.

Reynolds, Hugh W.; Gatchell, Charles J. **New technology for using low-grade hardwoods: System 6.** NE-INF-50-83. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.

Presents the System 6 process from the woods through final products. The process uses small-diameter, low-grade hardwood material and produces high-quality, high-valued standard-size blanks. Discusses specifications for materials and expected operating characteristics.

Ribblett, Gary C.; DeWalle, David R.; Helvey, J. David. **Chemistry of leachate from six different Appalachian forest floor types subjected to simulated acid**

rain. University Park, PA: Institute for Research on Land and Water Resources; The Pennsylvania State University; 1982; Final Rep. for USDA For. Serv. Agreement No. 23-557: 40 p.

chemistry of leachate from six different Appalachian forest floor types subjected to simulated acid rain storms was compared for three storm sizes and three heated storm applications.

ce, William W.; Gatchell, Charles J. **Application of System 6 technology to New England red oak.** Northern Logger. 31(12): 10-11, 20-21, 23; 1983. Presents results of a study to demonstrate that System 6 can convert low-quality wood into high-value furniture. Red oak bolts were processed into kiln dried, re-glued, C1F and better blanks in sizes to efficiently meet the cutting bills of two Massachusetts furniture manufacturers. Both furniture companies found the blanks very acceptable in size and quality. Return on investment for System 6 is calculated to be 27 percent.

th, Richard R.; Gansner, David A.; Birch, Thomas W.; Decker, Daniel J.; Kelly, John W. **Wildlife: A prime output of nonindustrial private forestlands in the Northeast.** In: Royer, Jack P.; Risbrudt, Christopher D., eds. Nonindustrial private forests: A review of economic and policy studies: Proceedings of a symposium; 1983 April 19-20; Durham, NC. Durham, NC: Duke University; 1983: 334-337.

unting, fishing, hiking, birdwatching, and other wildlife-related recreation activities are important to the economy and to the personal well-being of the region's residents and visitors. Taxpayer concerns for wildlife are evident from public opinion surveys and in the enactment of laws to improve and manage these resources. A majority of the forest-land owners in the Northeast own their forest land for recreation, esthetic enjoyment, or because it is part of a farm or residence. The primary recreational uses of private forest lands by the public are hunting and hiking. Habitat management is a major component of service forestry. Field foresters need training to incorporate more effectively wildlife habitat values into forest management activities.

thwell, F. M.; HacsKaylo, E.; Fisher, D. **Ecto- and endomycorrhizal fungus associations with *Quercus imbricaria* L.** Plant and Soil 71(1-3): 309-312; 1983. Seedlings were collected from 1-year-old shingle grown in fumigated and fertilized seedbeds at a nursery in western Kentucky. Root material from seedlings was washed free of soil and small segments stained for microscopic analysis of mycorrhizae development. External morphology of root segments is typically ectomycorrhizal, with characteristic rhizal mantle and Hartig net development evident in transverse sections of young ectomycorrhizae. In addition a *Glomus* species was frequently observed in the root cortex.

Rowntree, Rowan. **Geographical variation in urban vegetation structure.** In: Swann, Michael M.; Swann, Patricia Lambert; Lonsdale, Richard E., compilers. AAG Program Abstracts 1983; 1983 April 24-27; Denver, CO. Lincoln, NE: University of Nebraska-Lincoln; 1983. Abstract.

A sample of metropolitan centers across the U.S. provides data for speculation about how natural factors combine with human values and development history to form the contemporary urban forest which varies much less than many visible and invisible elements contributing to the individual character of cities. Cultural plant aggregations can now be understood in terms of the way land uses interact with the environment to create predictable patterns of, for example, forest density; e.g., Dayton, Ohio, and Sioux Falls, South Dakota, possess the same average canopy cover (22 percent) though existing in distinctly different ecological situations with separate development histories.

Rowntree, Rowan A.; Sanders, Ralph A.; Stevens, Jack C. **Evaluating urban forest structure for modifying microclimate.** In: Proceedings, 2nd national urban forestry conference; 1982 October 10-14; Cincinnati, OH. Washington, DC: American Forestry Association; 1983: 136-142.

The City of Dayton, Ohio, is being studied as a field laboratory to gain a better understanding of how the urban forest system operates to modify urban physical environments—air temperatures, air quality, and surface runoff. Based on the Dayton study, we present a 12-step procedure that provides a way to better understand the configuration of urban land use and cover types that make up the structure of an urban forest system. Once the configuration and structure of the urban forest system is quantified, mathematical simulation models can be developed to predict changes in environmental parameters that result from alterations in the urban forest structure.

Rowntree, Rowan; Stevens, Jack C. **Correlation of urban vegetation structure with land use and type.** In: Proceedings, 2nd national urban forestry conference; 1982 October 10-14; Cincinnati, OH. Washington, DC: American Forestry Association; 1983. Poster session.

Safford, L. O. **Silvicultural guide for paper birch in the Northeast (revised).** Res. Pap. NE-535. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 29 p.

This revised guide provides practical information on silvicultural treatments to grow paper birch as a timber crop. It covers treatments for existing stands, the regeneration of new stands, and subsequent culture to maturity. The stocking chart has been revised to reflect results of current growth studies.

Safford, L. O.; Jacobs, Rodney D. **Paper birch.** In: Silvicultural systems for the major forest types of the United States. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 145-147.

Sampson, T. L.; Barrett, J. P.; Leak, W. B. **A stocking chart for northern red oak in New England.** Res. Rep. No. 100. Durham, NH: University of New Hampshire, New Hampshire Agricultural Experiment Station; 1983. 14 p.

A stocking chart for northern red oak in New England, with curves representing minimum stocking for full site

utilization (B curve), and normal stand density (A curve) is presented and explained. Silvicultural considerations are discussed and use of the chart is illustrated.

Sanders, Ralph A.; Rowntree, Rowan A. **Classification of American metropolitan areas by ecoregion and potential natural vegetation.** Res. Pap. NE-516. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 15 p.

Classifies 279 American metropolitan areas by ecoregion and potential natural vegetation. The classification forms a baseline of expected vegetation structure and composition that can assist scientists and policymakers in making urban forestry generalizations about classes of cities.

Sanders, Ralph A.; Rowntree, Rowan. **Comprehensive management procedures for the urban forest ecosystem.** In: Proceedings, 2nd national urban forestry conference; 1982 October 10-14; Cincinnati, OH. Washington, DC: American Forestry Association; 1983. Poster session.

Sarles, Raymond L.; Hurst, Homer T., P.E. **Yellow-poplar comes of age.** Northern Logger. 32(4): 6-7; 28-29; 1983.

Yellow-poplar structural lumber was used to construct a four unit apartment in Blacksburg, Virginia. The apartment design was one of 19 award winners from HUD's 1980 Design Competition "Building Value into Housing." The unit was built as a national housing demonstration by HUD and Homer T. Hurst, P.E. The USDA Forest Service gave technical assistance in procuring grade-marked yellow-poplar lumber to project specifications.

Sarles, Raymond L.; Wartluft, Jeffrey L.; Whitenack, Kenneth R. **Chain saw felling in hardwood thinnings.** In: Proceedings, harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society; 1983: 58-65.

Production and efficiency rates were computed from time study and stem measurement data from four hardwood thinning operations in the central Appalachians. Felled trees averaged 9 to 10 inches in d.b.h. and 38 to 45 feet in merchantable length. Hourly production rates were determined from a regression equation expressing productive felling time as a function of merchantable volume and distance between successively felled trees. The average production rate for the combined operations was 2.4 cords per hour at an average felling efficiency of 49 percent. Efficiency was inversely related to delay time. Causes of delay—the largest time block in each felling cycle—were analyzed. Specialized training in thinning methods and techniques was recommended to increase worker efficiency and productivity.

Schier, G. A. **Sucker regeneration in some deteriorating Utah aspen stands: development of independent root systems.** Canadian Journal of Forest Research. 12: 1032-1035; 1982.

Root-sucker regeneration in deteriorating Utah aspen stands was examined. Suckers in only 1 of 12 clones examined had well-developed independent root systems. Most new roots died the same year they were initiated.

Schier, George A. **Vegetative regeneration of gambel oak and chokecherry from excised rhizomes.** Forest Science. 29(3): 499-502; 1983.

Gambel oak and chokecherry were vegetatively propagated from cuttings of rhizomes (underground stems). Shoots from rhizomes arose singly or in clusters from suppressed buds. Rhizome sprouting capacity was higher in chokecherry than in oak. Rhizomes from dormant oak required a cold treatment before they would sprout. Shoot production by oak and chokecherry rhizomes was significantly higher in light than in darkness. In comparison, shoot production from aspen roots was not affected by light conditions.

Schlitz, Harvey M.; Reams, Greg A.; Warner, William S.; Corcoran, Thomas J.; Brann, Thomas B.; Solomon, Dale S. **Impact of the spruce budworm in Maine 1975-80.** Orono, ME: University of Maine; 1983; Misc. Rep. 290. 35 p.

Combines and analyzes data from several reports to provide a graphic presentation and summary of the current budworm situation.

Schmitt, Daniel M. **Nacht thoughts of a program manager.** In: Corcoran, Thomas J.; Gill, Douglas R., eds. Recent advances in spruce-fir utilization technology: Proceedings of a symposium; 1983 August 17-19; Orono, ME. Washington, DC: Society of American Foresters; 1983: 47.

Schmitt, D. M. C.; Czapowskyj, M. M.; Allen, D. C.; White, E. H.; Montgomery, M. E. **Spruce budworm fecundity and foliar chemistry: Influence of site.** In: Proceedings, forest-defoliator—host interactions: A comparison between gypsy moth and spruce budworms; 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983: 97-103.

Two Maine spruce-fir stands with different soils were sampled to determine the relationship between spruce budworm weight (fecundity) and foliage quality. Although much of the variation in budworm weight was attributable to other factors, significant correlations between budworm weight and multiple foliar nutrient concentration variables suggest that foliage quality altering silvicultural practices such as fertilization may stimulate populations of the spruce budworm.

Schroeder, Herbert W.; Cannon, William N., Jr. **The contribution of trees to residential landscapes in Ohio.** In: America's hardwood forests—opportunities unlimited. Proceedings, 1982 convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American Foresters; 1983: 333-335.

Evaluates and develops models to predict the scenic quality of residential streets in Ohio towns; analyzes the role of shade tree commissions in street tree management.

Schroeder, Herbert W.; Cannon, William N., Jr. **The esthetic contribution of trees to residential streets in Ohio towns.** Journal of Arboriculture. 9(9): 237-243; 1983.

street trees are an important factor in the attractiveness of residential streets. However, large older trees that are the most attractive to the public are not necessarily the most desirable from a silvicultural point of view. Shade tree commissions, apparently formed in response to losses in esthetically valued trees, can create tree distributions that are less prone to catastrophic losses of attractive trees. Factors other than street trees also contribute to street esthetics and should be considered in shade tree management.

Chuhler, Albert T.; Wallin, Walter B. **A revised econometric model of the domestic pallet market.** Res. Pap. NE-522. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 5 p.

The purpose of this revised model is to project estimates of consumption and price of wood pallets in the short term. The model is intended to provide reliable estimates of the quantity of pallets required and their real price over a relatively short term of 1 to 5 years. It is not intended to be used in determining policy concerning the growth or decline of palletization or materials handling.

Cott, Charles T. **Example of midcycle updating to assess catastrophic change.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 555-557.

The 1982-83 midcycle update in Pennsylvania was designed to assess the impact of the gypsy moth caterpillar on oak forest types. To emphasize the oak resource, the proportion of nonoak sample plots was cut in half. Weighted regression was applied to the remeasured sample to update previous survey statistics to the present. The total cost was roughly one-fifteenth that of the previous full-scale survey.

Cott, Charles T.; Ek, Alan R.; Zeisler, T. R. **Optimal spacing of plots comprising clusters in extensive forest inventories.** In: Bell, John F.; Atterbury, Toby, eds. Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 707-710.

Clusters were substantially more efficient for estimating basal area, volume, and biomass, and to a lesser extent, area, than survey designs without clustering. Results were inconclusive for estimating growth.

Sendak, P. E. **Effect of oxygen, carbon dioxide, and nitrogen on maple syrup stored in plastic jugs.** Journal of Food Science. 47(5): 1741-1742; 1982. Six maple syrups were stored in the dark for 6 months in pigmented and unpigmented high-density polyethylene jugs at room temperature (72°F) in three gas environments—nitrogen, oxygen, and carbon dioxide. The syrup was analyzed for changes in flavor, color, and pH. A taste panel, tasting syrup from pigmented jugs only, detected flavor change in both the oxygen and carbon dioxide environments. There were statistically significant interactions for changes in both color and pH be-

tween gas and syrup treatments. The greatest darkening of color and decrease in pH were associated with the carbon dioxide. Jug pigmentation had no detectable effect on the syrup.

Sendak, Paul E. **Consumer attitudes about pure maple syrup.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 103-106.

Discusses the growing desire to expand markets for maple syrup. This means that producer and consumer will be separated by the normal marketing structure: producer—marketing intermediaries—final consumer. Information about consumers in these markets becomes more critical to the success of the marketing effort.

Sendak, Paul E. **Retail containers for pure maple syrup.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 107-109.

Discusses the two problems in packing syrup in the retail container. The first is to use proper packing procedures to ensure a sterile pack; the second is to minimize changes that take place in the syrup in the retail container over time.

Sendak, Paul E.; Bonyai, Susan A. **Firewood delivery systems in northern Vermont.** In: Proceedings, 6th international FPRS industrial wood energy forum; 1982 March 8-10; Washington, DC. Madison, WI: Forest Products Research Society; 1983: 221-225. The fuelwood market in Vermont has grown quickly to almost 400,000 cords per year in response to dramatic increases in oil price. The purpose of this study was to see how the market was organized for the delivery of fuelwood for domestic heating to the consumer. A literature review and individual case studies of fuelwood producers were used to examine the delivery methods.

Sendak, Paul E.; Jenkins, W. Lyman. **Market structure of the maple industry and syrup grading standards.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 98-102.

Discusses the elements for stabilizing or increasing maple production: Industry organizations have become international, encompassing the whole maple-producing region; government programs have continued in research and extension; new technology, especially in plastic tubing for sap production, has been widely adopted.

Shields, K. S.; Godwin, P. A. **U.S. Forest Service gypsy moth parasite research.** In: Proceedings, 1982 national gypsy moth review; 1982 December 7-9; Harrisburg, PA. Middletown, PA: Pa. Department of Environmental Research; 1983: 136-138.

Discusses current research at the Center for Biological Control of Northeastern Forest Insects and Diseases on

two gypsy moth parasites: Rogas lymantriae (Watanabe), a braconid, and Blepharipa pratensis (Meigen), a tachinid.

Shigo, A. L. **Measuring tree decay and vitality with a Shigometer.** Arbor Age. 3: 17-20; 1983.

By measuring the amount of electrical resistance caused by decaying material in a tree, the Shigometer allows an arborist to determine the extent of a tree's injuries without guesswork.

Shigo, Alex L. **Decay in trees.** In: Trees in the 21st Century. Berkhamsted, UK: AB Academic Publishers; 1983: 95-107.

Shigo, Alex L. **Tree Decay.** In: Proceedings, Korea-U.S.A. joint seminar on forest diseases and insect pests; 1982 September 22-30; Seoul, Korea. Seoul, Korea: Korea Science and Engineering Foundation and National Science Foundation, U.S.A.; 1982: 188-203.

A framework for an expanded concept of tree decay is given. The older concept of tree decay is based on the decomposition of wood—the breakdown of heartwood. The expanded concept addresses the orderly response of the living tree to injury and infection—compartmentalization, and the orderly infection of wounds by many microorganisms—successions.

Shigo, Alex L. **The relationship between better trees and better wood products from spruce and fir.** In: Corcoran, Thomas J.; Gill, Douglas R., eds. Recent advances in spruce-fir utilization technology: Proceedings of a symposium; 1983 August 17-19; Orono, ME. Washington, DC: Society of American Foresters; 1983: 217-220.

Many problems in wood products start in living trees. Low-quality trees produce low-quality products. Trees set boundaries to wall off infections. The boundaries and altered wood within boundaries are major causes of problems in products. A better understanding of trees and their care is needed for better products.

Shigo, Alex L. **Targets for proper tree care.** Journal of Arboriculture. 9(11): 285-294; 1983.

Proper tree care starts with a thorough understanding of trees and the many treatments used to help trees stay attractive, safe, and healthy. In the real working world of trees, it is almost impossible to do all the needed treatments perfectly all the time. A professional arborist must know what proper tree care is. Each part of each procedure for proper tree care becomes a target. The degree of professionalism of an arborist centers about knowing where the targets are, and how to hit them. The clearer the targets are to you, the better your chances of hitting them more often. Some of the targets for proper tree care are clarified here.

Shigo, Alex L. **Time to focus on tree health.** In: Proceedings, midwestern chapter International Society of Arboriculture; 1983 February 27-28, March 1; St. Charles, IL. St. Charles, IL: Midwestern Chapter International Society of Arboriculture; 1983.

Shigo, Alex L. **Tree defects: A photo guide.** Gen. Tech. Rep. NE-82. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 167 p.

This guide shows how discoloration and decay form in trees. An expanded concept of tree decay is given. After wounding, trees form boundaries to resist the spread of pathogens. The boundary-setting defense process is called compartmentalization, and a model of the process is CODIT. The expanded concept and the model are used to reexamine many other tree problems. Defects are major causes of low quality in trees. Use of the information in the guide can help foresters and urban foresters to grow healthier, higher quality trees.

Shigo, Alex L. **Trees and treatments. "Vooruitgang wetenschap moet leiden tot verbreding van inzicht."** Tuin & Landschap. 5(19): 25-27, 29; 1983.

A summary in Dutch of tree care information.

Shigo, Alex L. **Trees and treatments. "Verzorgingsmogelijkheden afhankelijk van herstellvermogen van bomen."** Tuin & Landschap. 5(20): 24-25; 1983.

A summary in Dutch of tree care information.

Shigo, Alex L. **Trees and treatments. "Ongeschieden houden van afgrensling voorkomt erger."** Tuin & Landschap. 5(21): 26-27, 29; 1983.

A summary in Dutch of tree care information.

Shigo, Alex L. **Trees: Treatments and trade-offs.** Arbor Age. 2(6): 16, 17, 20, 21; 1983.

Discusses wound dressings, cavity filling, scribing, cabling and bracing injections, and pruning in light of what a tree is. Indicates that there are always trade-offs that must be made with new adjustments for old treatments.

Shigo, Alex L.; Dorn, Donald; Lee, Herbert C.

Selections of maple and birch trees with high resistance to spread of decay associated with wounds. In: 28th Northeastern forest tree improvement conference: Proceedings 1983; 1982 July 7-9; Durham, NH. Durham, NH: University of New Hampshire; 1983: 110-117.

Sugar maple, paper birch, and yellow birch trees selected as superior for form on the White and Green Mountain, Allegheny, Monongahela, and Nicolet National Forests were wounded with drill holes. After one and two growth seasons, the columns of discolored wood associated with the wounds were determined with the twisted-wire electrode and the Shigometer. Double-needle electrodes and the Shigometer were used to determine cambial electrical resistance of the superior trees, comparison trees, and from 15 to 30 neighboring trees of the same species. From these data, trees with the smallest columns of defect and the highest vitality were selected as superior for form, growth rate, and the resistance to decay.

Shigo, Alex L.; Roy, Karl. **Violin woods: A new look.** Durham, NH: University of New Hampshire; 1983. 66 p.

Violin woods, especially spruce and maple, are discussed for the violin builder from the viewpoint of new con-

pts on trees and wood defects, and of new electrical equipment for testing wood. The paper connects information on tree biology and tree response systems to injury and infection in such a way that the results can be easily understood and used by violin builders. Results of studies on wood from tree to finished violin are given. Major consideration is given to the condition of the wood in the living tree as it will affect the characteristics of the wood in the violin.

Shigo, Alex L.; Shortle, Walter C. **Wound dressings: Results of studies over 13 years.** Journal of Arboriculture. 9(12): 317-329; 1983. Many materials were used in and on experimentally inflicted wounds in many studies over a 13-year period. No material prevented decay. The individual tree had a greater effect on the wound than the treatments. Some individual trees of a species closed and compartmentalized wounds rapidly and effectively, regardless of treatment, while other trees did not close and compartmentalize treated or control wounds. The width of healthy wood behind wounds in red maple was the major factor affecting the course of the wound. Results are given from wounds on 275 treated and dissected trees.

Shortle, W. C.; Ostrofsky, A. **Decay susceptibility of wood in defoliated fir trees related to changing physical, chemical, and biological properties.** European Journal of Forest Pathology. 13(1): 1-11; 1983. Studies of the physical, chemical, and biological properties of wood from balsam fir trees indicated that as cambial electrical resistance increased in defoliated trees, the susceptibility of wood to decay seemed to increase. Increased susceptibility of wood to decay was associated with decreasing electrical resistance of wood as the tree lost its capacity to compartmentalize decaying wood.

Smith, C. T.; Hornbeck, J. W. **Changes in soil solution chemistry after forest harvest depend on soil drainage class.** Bulletin of the Ecological Society of America. 64(2): 65; 1983.

Smith, H. Clay. **Growth of Appalachian hardwoods kept free to grow from 2 to 12 years after clearcutting.** Res. Pap. NE-528. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 6 p.

Free-to-grow sapling-size yellow-poplars of seedling origin in young stands outgrew similar black cherry and red oak in both d.b.h. and total height. Sugar maple did not respond to the free-to-grow treatment.

Smith, H. Clay; Della-Bianca, Lino; Fleming, Harvey. **Appalachian mixed hardwoods.** In: Final environmental impact statement for regional guide-Eastern Region. Milwaukee, WI: U.S. Department of Agriculture, Forest Service, Eastern Region; 1983: D-4-10.

Smith, H. Clay; Della-Bianca, Lino; Fleming, Harvey. **Appalachian mixed hardwoods.** In: Silvicultural systems for the major forest types of the United States. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 141-144.

Smith, H. Clay; Lamson, Neil I. **Precommercial crop-tree release increases diameter growth of Appalachian hardwood saplings.** Res. Pap. NE-534. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 7 p.

Hardwood, codominant sapling crop trees 25 to 39 feet tall in even-aged stands were released in a West Virginia study. Trees were located on two oak sites: good oak site index 75 and fair oak site 63. Species studied were black cherry, sweet birch, and yellow-poplar. Three-year results indicated that the trees generally responded to release; the 3-year d.b.h. growth of released trees was 0.2 to 0.4 inch greater than that of unreleased trees. Height growth did not increase.

Smith, Harvey R. **Gypsy moth predators-can they service woodland management?** Connecticut Timber Trends. IV(4): 6-8; 1983.

At least 50 species of birds and 20 species of mammals are known to eat gypsy moths. Common bird predators include the black-capped chickadee, blue jay, red-eyed vireo, rufous-sided towhee, scarlet tanager, northern oriole, catbird and robin. Mammalian predators include the white-footed mouse, several species of shrews, squirrels, chipmunks, skunks, red-backed voles, raccoons, and opossum. Often foresters and homeowners unknowingly turn good wildlife habitats into unsuitable habitats by removing brush. Reducing food, cover, and nesting sites means a loss in diversity and density of predators.

Smith, Harvey R. **Wildlife and the gypsy moth.** In: Yahner, Richard H., ed. Transactions of the Northeast Section, The Wildlife Society: 40th Northeast Fish and Wildlife Conference; 1983 May 15-18; West Dover, Vt. Publisher unknown; 1983: 66. Abstract.

Predators of the gypsy moth are opportunistic feeders; selection of gypsy moth is largely a function of the availability of other foods. The gypsy moth predator/prey system is complex; many wildlife species eat gypsy moths. Avian, mammalian, and invertebrate predators are the most common and important, though amphibians, reptiles, and fish occasionally prey on larvae and adults.

Solomon, Dale S. **Changes in growth of spruce-fir stands in the Northeast under varying levels of attack by the spruce budworm.** In: Renewable resource inventories for monitoring changes and trends: international conference; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University; 1983: 93-96.

The defoliation of spruce and fir trees in the Northeast causes a reduction in upper bole increment. External influences, such as insect attack, place trees under stress and result in a growth loss and eventual reduction in yield. Measurements of tree characteristics and severity of attack have been related to the resulting radial increment over the bole of tree to predict changes in bole volume growth response for long periods of time. Continued heavy defoliation can result in up to 50 percent reduction in growth that is not regained, and is not part of the harvest yield. The resulting change is noticed first in the upper bole, with no appar-

ent change in the radial increment at breast height. Different patterns of defoliation and varying amounts of protection are analyzed, providing forest managers with methods of predicting the growth of trees in stands under attack.

Solomon, Dale S. **Use of discriminant equations to classify birch in the Northeast.** In: 28th Northeastern forest tree improvement conference: Proceedings 1983; 1982 July 7-9; Durham, NH. Durham, NH: University of New Hampshire; 1983: 77-93.

Leaf, seed, and bract measurements from three species of birch were used to classify intraspecific crosses and their hybrids. Seed and bract measures provide a sufficient basis for discriminating among superior trees that have been selected as potential breeding stock. The occurrence of introgression in both the parents and progeny can be established.

Solomon, Dale S.; Frank, Robert M. **Growth response of managed uneven-aged northern conifer stands.** Res. Pap. NE-517. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 17 p.

The growth response of trees in spruce-fir-hemlock stands was recorded from plots that were managed to control stand density, species composition, length of harvest interval, and salvage of mortality. Basal area, volume, and diameter increment are presented by species and size classification for harvesting intervals of 5, 10, and 20 years.

Solomon, Dale S.; Seegrist, Donald W. **Growth and yield analysis of thinned uneven-aged spruce and fir stands in Maine.** In: Planning, performance and evaluation of growth and yield studies; 1979 September 17-21; Oxford, UK Occas. Pap. 20. Oxford, UK: Commonwealth Forestry Institute; 1983: 149-156.

The selection system of silviculture was used to reduce the growing stock in uneven-aged spruce-fir stands every 5, 10, and 20 years. Statistical procedures were used to estimate mean accretion rates within measurement periods for each of the harvesting cycles. Likelihood procedures for an incomplete multivariate model with correlated observations were used to estimate the mean vectors. Although the treatment means were statistically significant, the differences are small. Differences among treatments may become evident as more measurements are taken.

Solomon, J. D.; Donley, D. E. **Bionomics and control of the white oak borer.** Res. Pap. SO-198. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1983. 5 p.

The white oak borer is one of the most serious trunk borers of young trees in the white oak group in the eastern United States. Adult beetles, emerging from late April through May in the South and from mid-May to mid-July in its northern range, oviposit in the cambium through niches chewed in the bark. Newly hatched larvae tunnel directly into the sapwood. Larval galleries in the trunk extend 2 to 6 cm obliquely upward, 8 to 17 cm vertically, and then turn back to the bark surface. Part of a brood develops in 3 years, while the

remainder requires 4 years. The borer attacks trees 3 to 55 cm in diameter at breast height (dbh), but prefers stem diameters from 9 to 20 cm. Open-grown trees are favored for attack. Sap-out mortality and woodpecker predation are the major natural controls. Removal of brood trees and managing for non-host species will help minimize losses.

Southard, Susan G.; Houseweart, Mark W.; Jennings, Daniel T.; Halteman, William A. **Size differences of laboratory reared and wild populations of *Trichogramma minutum* (Hymenoptera: Trichogrammatidae).** Canadian Entomologist. 114: 693-698; 1982.

Body length, head width, and abdomen width were used to determine size differences between laboratory-reared and wild populations of *Trichogramma minutum* Riley. Six separate groups of *T. minutum* were measured: three groups were from *Sitotroga cerealella* (Olivier) eggs, two from spruce budworm *Choristoneura fumiferana* (Clemens) eggs, and one from wild populations of spruce budworm. Female *T. minutum* from spruce budworm (large host) eggs were significantly larger for all body dimensions than *T. minutum* from *S. cerealella* (small host) eggs. Male *T. minutum* from field-collected spruce budworm eggs were significantly larger for all body dimensions than *T. minutum* reared for more than one generation in *S. cerealella* eggs.

Stout, S. L. **Computer program helps foresters write prescriptions for Allegheny hardwoods.** Allegheny News. Allegheny Society of American Foresters; 1983 Spring: 14-15.

Research results from the last decade of research at the Warren, Pennsylvania, Forestry Sciences Laboratory have been capsulized into a system of stand inventory, analysis, and prescription. The system, called SILVAH, for Silviculture of Allegheny Hardwoods, is available for both manual and computer implementation. This paper briefly summarizes the inventory procedures, analysis techniques, and prescription-identification procedure called for by the system, and refers the reader to sources of further information.

Talerico, Robert L. **Summary of life history and hosts of the spruce budworms.** In: Proceedings, forest defoliator-host interactions: A comparison between gypsy moth and spruce budworms; 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983: 1-4.

Talerico, Robert L.; Montgomery, Michael, tech. coords. **Proceedings, forest defoliator-host interactions: A comparison between gypsy moth and spruce budworms;** 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 141 p.

Fosters communication between researchers with active research projects designed to understand the relationships between the host plant and forest defoliator feeding behavior, growth, and reproduction.

Tilghman, Nancy G. **Breeding birds of urban woodlands.** In: Yahner, Richard H., ed. Transactions of the

Northeast Section, The Wildlife Society: 40th Northeast Fish and Wildlife Conference; 1983 May 15-18; West Dover, VT. Publisher unknown ; 1983: 170. Poster session abstract.

the effects of size of woodland, general vegetation characteristics, and level of human activity on the breeding bird communities of 32 isolated urban woodlands were examined.

ghman, Nancy G. **Deer densities and forest regeneration.** In: 1st Eastern wildlife damage control conference, presentation summaries; 1983 September 27-30; Ithaca, NY. Ithaca, NY: Cornell University; 1983: 17. Abstract.

nson, Floyd G. **The personal-use firewood program on three national forests: a cost analysis.** Res. Pap. NE-527. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.

the national forests' personal-use firewood program was studied to determine operating costs. Seventeen national forest districts studied expended more than \$18,000 to provide more than 25,000 personal-use firewood permits during the calendar year 1981; 86 percent of the permits were for firewood, mostly dead down wood. The remaining 14 percent was for firewood sold to households in the form of pickup loads or personal-size boundaries of marked timber.

nson, Floyd G. **Size-volume classification of Appalachian hardwood sawlog harvesting residue.** Southern Journal of Applied Forestry. 7(1): 24-26; 1983.

length and diameter, not quality, limit the use of low-grade roundwood in a number of wood manufacturing processes; therefore the length, diameter, and volume relationship was examined for bolewood hardwood log residue from sawlog-only harvesting operations. Estimations were made of available residue by length and minimum diameter as well as the volume of bolts or logs of a given diameter and length that can be cut from bolewood residue.

pett, J. T.; Bogle, A. L.; Shigo, A. L. **Response of balsam fir and hemlock roots to injuries.** European Journal of Forest Pathology. 12: 357-364; 1983.

ill wounds in balsam fir and hemlock roots activated nonspecific resistance mechanisms of compartmentalization in wood and necrophylactic periderm in bark. Tangential bands of resin ducts localized around the wounds constituted the barrier zones in the secondary xylem of conifer roots. Barrier zones were more extensive in roots that showed symptoms characteristic of invasion by fungi and bacteria after wounding. This observation supports an expanded definition of barrier zones; barrier zones may form not only in response to mechanical wounds but also in response to xylem injury caused by pathogens.

ttton, L. M.; Martin, C. W.; Hornbeek, J. W.; Pierce, R. S.; Federer, C. A. **Organic matter and nitrogen content of a central hardwood forest in Connecticut.** In: Proceedings, 4th central hardwood forest conference; Lexington, KY; Lexington, KY: University of Kentucky; 1982: 271-284.

Four adjacent, 6-ha watersheds in a central hardwood forest in Connecticut are being studied to assess the impact of whole-tree and selective harvesting operations on the forest ecosystem. Since April 1980 we have been collecting baseline data on species distribution, basal area, mass and nutrient content of above-ground living and dead trees, and on the organic matter and nitrogen content of the soil. Before cutting, dominant oak-birch vegetation in the forest was 80 to 110 years old.

Tritton, Louise M.; Valentine, H. T.; Furnival, G. M. **A new procedure for estimation of tree biomass and nutrient content.** In: Problems in forest biomass mensuration and growth and yield studies; 1983 October 3-7; Orleans, France. No. 19. Paris: National Institute of Agronomy Research; 1983: 335-341.

A new procedure for estimation of tree biomass was developed and field-tested on eight felled trees of various species and diameters. A combination of randomized branch sampling and importance sampling was used to select a disk from each tree with probability proportional to size. The fresh weight of each tree was estimated from the weight-per-unit-thickness of the appropriate disk, and the estimate was compared with the actual fresh weight of the tree. Sampling errors ranged from 5.6 to 14.4 percent of the actual fresh weights of the trees. The procedure described is efficient, accurate, and can be used to estimate dry weight, volume, or nutrient content as well as fresh weight.

Tubbs, Carl H. **Avoidance mechanisms in allelopathic relationships of sugar maple and yellow birch.** In: America's hardwood forests—opportunities unlimited. Proceedings, 1982 convention of the Society of American Foresters; 1982 September 19-22; Cincinnati, OH. Washington, DC: Society of American Foresters; 1983: 189-193.

Seedling sugar maple survive far better than yellow birch in environments suitable for good growth of both even though birch is the faster growing species. One reason for the success of maple when growing with birch is that maple produces a chemical that inhibits growth of birch. In spite of this and other advantages of maple, some birch survive; apparently birch and maple partition the soil resource since their root-growth rhythms are opposed. Other possibilities for escape of birch from maple competition are discussed.

Tubbs, Carl H. **Regeneration of quality northern hardwoods.** In: Proceedings, hardwood forest management and utilization symposium; 1982 October 25-26; Orono, ME. Misc. Rep. 279. Orono, ME: University of Maine, Maine Agricultural Experiment Station; 1983: 6-9.

The regeneration of high-quality northern hardwoods and the means of attaining regeneration objectives are discussed.

Tubbs, Carl H.; Jacobs, Rodney D.; Cutler, Dick. **Northern hardwoods.** In: Silvicultural systems for the major forest types of the United States. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 121-127.

U.S. Department of Agriculture, Forest Service. **Wood defects - from tree to product.** NE-INF-55-83.

Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 9 p.

Valentine, Harry T. **An approach to modeling the consequences of beech mortality from beech bark disease.** In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 8; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 134-137.

Changes to an extant model of forest growth and transition that allow an evaluation of the consequences of beech bark disease are outlined. Required are a function to scale beech growth for the effects of beech bark disease, a function to predict beech mortality from beech bark disease, and a function that predicts root-sprout regeneration of beech.

Valentine, Harry T. **Budbreak and leaf growth functions for modeling herbivory in some gypsy moth hosts.** Forest Science. 29(3): 607-617; 1983.

Functions are reported that predict percent budbreak and average leaf dry weight from elapsed degree-days (threshold = 4.4°C) for six important hosts of the gypsy moth: Quercus alba, Q. rubra, Q. velutina, Fagus grandifolia, Acer rubrum, and A. saccharum. Budbreak observations are summarized for Betula lenta and B. alleghaniensis. Day 105 was the best single date to start counting degree-days to predict percent budbreak for all species, years, and locations. Simultaneous solution of the red oak leaf growth function and published gypsy moth larval growth and consumption functions predicted that an average larva will consume about 1,115 mg dry leaf weight, and drop about 156 mg.

Valentine, Harry T. **Defoliation induced changes in foliage chemistry and effects on gypsy moth pupal weight.** In: Parker, Bruce L.; Hanson, Patricia M.; Teillon, H. Brenton, eds. Proceedings, 15th annual Northeastern forest insect work conference; 1982 March 11; Portland, ME. MP 108. Burlington, VT: University of Vermont Agricultural Experiment Station; 1983: 2. Abstract.

Results of induced defoliation showed that the concentration of most constituents changed from year to year and that defoliation treatment did little to augment these changes in either species.

Valentine, Harry T. **The influence of herbivory on the net rate of increase of gypsy moth abundance: A modeling analysis.** In: Proceedings, forest-defoliator-host interactions: A comparison between gypsy moth and spruce budworms; 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983: 105-111.

A differential equation model of gypsy moth abundance, average larval dry weight, and food abundance was used to analyze the effects of changes in foliar chemistry on the net per capita rate of increase in a gypsy moth population. If relative consumption rate per larva is unaffected by herbivory, a reduction in the nutritional

value of foliage reduces the net rate of increase at relatively low larval densities, and increases the larval density needed to bring about starvation. This result is achieved by reducing larval assimilation efficiency, or by increasing larval death rate, or both, in response to declining nutritional value of foliage associated with herbivory.

Valentine, Harry T.; Wallner, William E.; Wargo, Philip M. **Nutritional changes in host foliage during and after defoliation, and their relation to the weight of gypsy moth pupae.** Oecologia (Berlin). 57: 298-302; 1983.

Black oak and gray birch trees were defoliated in 0, 1, 2, or 3 successive years. Concentrations of 8 minerals, 4 sugars, and 25 amino acids in the foliage of these trees were measured when gypsy moth reared on them were in instars I, III, IV, and V. These concentrations were tested for changes among years, and changes due to previous- and current-year defoliations. Most foliar constituents varied in concentration from year to year, though relatively few were affected by current or previous defoliations. Some implications of the apparent relations for gypsy moth larval growth and population dynamics are discussed.

Vogel, Willis G. **Ecological considerations in designing and selecting reclamation equipment.** In: Vegetative rehabilitation & equipment workshop: 37th annual report; 1983 February 13-14; Albuquerque, NM. Missoula, MT: Equipment Development Center, USDA Forest Service; 1983: 59-63.

It has been recommended that the Vegetative Rehabilitation and Equipment Workshop identify and promote a better understanding of the ecology of the land to be treated as a first step in designing and modifying equipment. The precept also is applicable to the selection of existing equipment. This paper describes where and how ecological principles may relate to and be considered in the design, modification, and selection of equipment for reclaiming and vegetating disturbed lands.

Vogt, A. R.; Redett, R. B.; Foulger, A. N.; Barnard, J. E. **Ohio's forests are growing.** Ohio Woodlands. 21(4): 4-5, 9; 1983.

Wallace, Oliver P.; Leak, William B. **Returns from short-term ownership of two northern hardwood lots.** In: Proceedings, New England section 63rd annual winter meeting; the future of forests in New England and Eastern Canada; 1983 March 9-11; Burlington, VT. SAF 83-05, Book II. Burlington, VT: New England Section, Society of American Foresters; 1983: 107-111.

Timberland ownership in New England traditionally has had a high turnover rate. Average tenure varies from about 10 to 25 years, depending upon the type of owner. We have assumed a 15-year ownership period, and attempted to assess the consequences of such short tenure on the management of non-industrial woodlots in New Hampshire.

Wallin, Walter B. **Computerized pallet design procedures are here to stay.** Pallet Enterprise. 2(6): 23-24; 1983.

During the past 10 years, the pallet manufacturing industry has graduated from using a trial-and-error process for designing pallets to adoption of a sophisticated computerized process employing the newest engineering design procedures coupled with an economic evaluation of the design. This procedure enables the manufacturer to employ any desired mix of species to produce a pallet that will safely support the loads intended and provide the buyer a pallet with the desired life expectancy and cost per trip. The future of the pallet producing industry is committed to using computers as a necessary tool which is equally as essential as the saws and nailing machines.

Vallin, Walter B.; Whitenack, Kenneth R. **Application of joint performance criteria to pallet design.** Pallet Enterprise. 1(5): 24-26; 1982.

Vallin, Walter B.; Whitenack, Kenneth R. **Fastener equivalence guides—supplementary considerations.** Pallet Enterprise. 2(1): 25-27; 1982.

Vallin, Walter B.; Whitenack, Kenneth R. **Fastener equivalence guides for wooden pallets.** Pallet Enterprise. 1(6): 25-29; 1982.

Procedures are presented for determining equivalent pallet joint performance with respect to the new pallet standards published by the National Wooden Pallet and Container Association. Fastener quality index (FQI) and fastener shear index (FSI) are discussed as they relate to the joint characteristics and the pallet standards. Nail manufacturers can compute the FQI and FSI for their fasteners from measurements of wire diameter, thread-crest diameter, number of helixes per inch, and MIBANT bend angle. The pallet manufacturer, knowing the FQI and FSI of the fastener, can then determine the appropriate fastener for any pallet construction based on the end-use requirements of the pallet user.

Vallner, William E. **Gypsy moth and the forest land manager.** Connecticut Timber Trends. 4(1): 4,5,8; 1983.

The first of a series of articles aimed at providing woodland owners and managers with information upon which to base their decisions about dealing with the gypsy moth.

Vallner, William E. **Gypsy moth host interactions: A concept of room and board.** In: Proceedings, forest defoliator—host interactions: A comparison between gypsy moth and spruce budworms; 1983 April 5-7; New Haven, CT. Gen. Tech. Rep. NE-85. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983: 5-8.

The influence of host type and condition on the bioecology of gypsy moth are discussed from the viewpoint of room and board. Larval establishment was higher on preferred hosts; less than 5 percent migrated off them. Nonpreferred hosts lost 10 to 25 percent of the larvae. Susceptibility of gypsy moth larvae to nucleopolyhedrovirus increased following 1 or 2 years of defoliation.

Vallner, William E.; Dubois, Normand R.; Grinberg, Phyllis S. **Alteration of parasitism by Rogas lymantriae**

(Hymenoptera: Braconidae) in Bacillus thuringiensis-stressed gypsy moth (Lepidoptera: Lymantriidae) hosts. Journal of Economic Entomology. 76(2): 275-277; 1983.

The addition of a sublethal dose of Bacillus thuringiensis Berliner (Bt) to diet fed to Lymantria dispar (L.) prolonged developmental time of 2nd instars up to 3 days. Extension of developmental time increased parasitism by Rogas lymantriae Watanabe, which prefers 2nd instars less than 5 days old. However, L. dispar larvae fed on Bt-diet yielded significantly fewer female R. lymantriae than those fed only diet; Bt reduced L. dispar larval size and prompted ovipositing R. lymantriae to deposit more unfertilized eggs. Use of a sublethal dose of Bt for initial establishment of R. lymantriae and its effect on the level of parasitization of gypsy moth are discussed.

Walters, Russel S. **Sugar maple sap collection.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 16-24.

Discusses methods for collecting maple sap: bucket collection, plastic bags, and plastic pipelines.

Walters, Russell S. **Sugarbush management.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 25-37.

Discusses management needs for improving and developing sugarbushes.

Walters, Russell S.; Yawney, Harry W. **Sugar maple tapholes.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 8-15.

Discusses characteristics of the tapholes, such as diameter, depth, location, number and so on.

Wargo, Philip M. **Armillaria mellea and mortality of beech affected by beech bark disease.** In: Proceedings, I.U.F.R.O. beech bark disease working party conference; 1982 September 26 - October 8; Hamden, CT. Gen. Tech. Rep. WO-37. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 81-88.

The role of Armillaria mellea in the mortality of beech trees affected by beech bark disease was determined by excavating root systems of beech trees infested by beech scale or also infected by the bark fungus, Nectria coccinea var. faginata. Only trees infected by Nectria showed any effect on the root system. They had fewer 4th-order nonwoody branch roots and less starch than trees only infested by scale. A. mellea colonized roots only on Nectria-infested trees and was found consistently on roots associated circumferentially with areas of stem bark necrosis caused by Nectria.

Wargo, Philip M. **Effects and consequences of stress on root physiology.** Journal of Arboriculture. 9(7): 173-176; 1983.

Because roots are out of sight, they are too often out of mind when the effects of stress on overall tree condition are considered. A description and discussion of tree root structure and function is followed by some basic information on root physiology. The effects of various stresses that affect the roots directly and indirectly are considered in relation to root structure and physiology, and the consequences of altered root physiology on tree health are discussed.

Wargo, Philip M. **The interaction of *Armillaria mellea* with phenolic compounds in the bark of roots of black oak.** *Phytopathology*. 73(5): 838; 1983. Abstract A574.

Wargo, Philip M.; Houston, David R.; LaMadeleine, Leon A. **Oak decline.** For. Insect & Dis. Leaflet 165. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983. 8 p.

Oak decline is initiated by stresses, which can disappear before effects are manifested. A systematic evaluation of the problem can usually reveal the initiating factors and the agents responsible for mortality. Practices to promote good tree health can reduce the potential impacts of damage by oak decline.

Wargo, Philip M.; Montgomery, Michael E. **Colonization by *Armillaria mellea* and *Agrilus bilineatus* of oaks injected with ethanol.** *Forest Science*. 29(4): 848-857; 1983.

Roots of undeciduous black and white oaks were injected with water or ethanol (5, 20, or 50 percent) to determine if ethanol could induce invasion by *Agrilus bilineatus* and/or *Armillaria mellea*—two secondary invaders commonly associated with mortality of defoliated trees. Trees of both species injected with 50 percent ethanol experienced greater attack by *A. bilineatus* and had the greatest amount of tissue necrosis up the stem than trees in the other treatments. *A. mellea* colonized roots of both oak species that were injected with 20 or 50 percent ethanol, but colonization was greater in trees injected with 50 percent ethanol. The fungus was confined mainly to tissues killed by the ethanol.

Wartluft, Jeffrey L. **How to season firewood.** *Popular Mechanics*. 160(3): 122; 1983.

Ten cords of Appalachian hardwood firewood were tested to determine drying time and the effect of season of year, species, piece length, splitting, stacking method, exposure, cover, and solar assistance on the drying rate. Results indicated that firewood should be cut to length, split, and covered at least 4 summer months before the heating season. Use of a solar dryer can double the summer drying rate.

Wartluft, Jeffrey L. **Seasoning Appalachian hardwood firewood.** In: *Proceedings, 6th international FPRS industrial wood energy forum '82*; 1982 March 8-10; Washington, DC. Dubuque, IA: Kendall/Hunt Publishing Company; 1983: 175-186. Vol. 1.

Wendel, G. W.; Della-Bianca, Lino; Russell, James; Lancaster, Kenneth F. **Eastern white pine, including eastern hemlock.** In: *Final environmental impact statement for the regional guide—Eastern Region.*

Milwaukee, WI: U.S. Department of Agriculture, Forest Service, Eastern Region; 1983: D-74-84.

Wendel, G. W.; Della-Bianca, Lino; Russell, James; Lancaster, Kenneth F. **Eastern white pine, including eastern hemlock.** In: *Silvicultural systems for the major forest types of the United States*. Agric. Handb. 445. Washington, DC: U.S. Department of Agriculture, Forest Service; 1983: 131-134.

Weseloh, R. M.; Andreadis, T. G.; Moore, R. E. B.; Anderson, J. F.; Dubois, N. R.; Lewis, F. B. **Field confirmation of a mechanism causing synergism between *Bacillus thuringiensis* and the gypsy moth parasitoid, *Apanteles melanoscelus*.** *Journal of Invertebrate Pathology*. 41: 99-103; 1983.

Wharton, Eric H. **Changing attitudes about tree merchantability in the Northeast.** *Northern Logger*. 32(7): 16-17; 1983.

Merchantability limits only recently have been extended to include tree tops, poorly formed trees, rotten trees, and small trees. This increased resource is being recovered today by whole-tree chipping. Recent tree biomass studies show that 47 percent of the total resource is in nonconventional sources of wood material.

Wharton, Eric H.; Bones, James T. **Biomass assessment of the aboveground wood resource.** In: *Proceedings, 6th international FPRS industrial wood energy forum '82*. 1982 March 8-10; Washington, DC. Dubuque, IA: Kendall/Hunt Publishing Co.; 1983: 106-109.

In the future, inventory data will be needed for a more complete range of resource attributes so that planners will be able to determine the optimum mix of forest products. For this reason, timber on low productivity lands, dead and down trees, wood on nonforest areas such as fencerows, and scattered trees in urban areas must be given more consideration. And, as wildlife and range habitat information begins to be collected, estimates of shrub biomass will be needed.

White, M. S.; Curtis, M. L.; Sarles, R. L.; Green, D. W. **Effects of outside storage on the energy potential of hardwood particulate fuels: Part I. Moisture content and temperature.** *Forest Products Journal*. 33(6): 31-38; 1983.

Three fuels—hardwood whole-tree chips, bark, and sawdust—were stored in piles 10, 15, and 20 feet high. Internal pile temperatures rose rapidly during the first weeks to highs of 45°C for whole-tree chips and 73°C for bark and sawdust. In the bark and chip piles, these temperatures fluctuated seasonally. The interior temperature of the sawdust pile was insensitive to ambient temperature changes and declined slowly throughout the remainder of the study. Within the first 60 to 120 days of storage, the surfaces of all piles became saturated with moisture. The interior zones of the bark and sawdust piles remained at or slightly above the original moisture content (MC) while the corresponding regions of the chip pile exhibited some drying. After 1 year's time, the weighted average MCs of chips, bark, and sawdust increased by 84, 108, and 191 percent, respectively, over the original MCs.

White, M. S.; Curtis, M. L.; Sarles, R. L.; Green, D. W. **Effects of outside storage on the energy potential of hardwood particulate fuels: Part II. Higher and net heating values.** Forest Products Journal. 33(11/12): 61-65; 1983.

Higher heating values of hardwood whole-tree chips, bark, and sawdust declined by 9, 7, and 3 percent, respectively by the end of 1 year. These decreases, coupled with increases in moisture content, resulted in significant declines in average net heating values. After 1 year of storage in 15-foot piles, average net heating values of whole-tree chips, sawdust, and bark declined by 24, 40, and 50 percent, respectively. Over half of the decline took place in the first 60 days. Whole-tree chips lost less when stored in 20-foot piles than when stored in 10- or 15-foot piles. Losses can be reduced by storing larger sized particles, increasing pile heights, and shortening storage cycles to 60 days or less.

Wiant, H. V., Jr.; Lamson, N. I. **Site index equations for evenaged stands in northwestern West Virginia.**

West Virginia Forestry Notes. 10: 11-12; 1983. Equations are presented for previously published site-index prediction tables for northern red, scarlet, black, white, and chestnut oaks in northwestern West Virginia. For northern red, scarlet, and black oaks, 88 percent of the formula values were within ± 1 foot of the table values; for white and chestnut oaks 93 percent of the formula values were within ± 1 foot of the table values.

Widmann, Richard H. **Pulpwood production in the Northeast—1981.** Resour. Bull. NE-76. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 23 p.

This annual report contains information compiled from a canvass of all pulp mills that use pulpwood produced in the 14 Northeastern states. From 1980 to 1981, pulpwood production decreased 2 percent, roundwood production dropped less than 1 percent, and chipped residues dropped 6 percent. Current pulpwood production is 8.3 million cords, of which 6.1 million cords are roundwood and 2.2 million cords are from chipped manufacturing residues.

Widmann, Richard H. **Pulpwood production in the Northeast—1982.** Resour. Bull. NE-79. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 22 p.

This annual report contains information compiled from a canvass of all pulp mills that use pulpwood produced in the 14 Northeastern states. In 1982, 6.3 million cords of pulpwood roundwood were harvested from the forests of the Northeast Region. This was a new high for roundwood production. In addition, 2.1 million cords of chipped sawmill slabs, edgings, and other manufacturing residues were used for the production of pulp. Total pulpwood production was 2 percent more than the 1981 production, making the 1982 production just shy of the record high set for the Northeast in 1980.

Widmann, Richard H.; Brooks, Robert T., Jr.; Rowland, E. Bruce. **Pulpwood harvest intensity in the Northeast—1981.** Tech. Note B51. Norris, TN:

Tennessee Valley Authority, Division of Land and Forest Resources; 1983. 19 p.

Graphics illustrating 1981 data for pulpwood production and intensity are shown by county for 14 Northeastern states. A brief explanation of the graphics is included.

Wilkinson, R. C. **A reexamination of the relationship between bark thickness and susceptibility of eastern white pine to white-pine weevil attack.** In: Proceedings, 28th Northeastern forest tree improvement conference; 1982 July 7-9; Durham, NH. Durham, NH: University of New Hampshire; 1983: 134-139.

The relationship between bark thickness at breast height and susceptibility of eastern white pine to repeated attacks by the white-pine weevil was reexamined. The least weeviled trees in a 25-year-old provenance test plantation had the thinnest bark, but overall the correlation between number of weevil attacks and bark thickness was low ($r=.24$). The least weeviled trees were also the smallest in diameter at breast height (d.b.h.), and the correlation between d.b.h. and bark thickness was high. Mean bark thickness adjusted for variation in d.b.h. by covariance analysis was not significantly related to numbers of weevil attacks, and bark thickness varied widely within trees. Therefore, bark thickness at breast height does not seem to be a reliable criterion for distinguishing highly susceptible from more weevil-resistant white pines.

Wilkinson, R. C. **Seed source variation in susceptibility of eastern white pine to white-pine weevil attack.** In: Proceedings, 28th Northeastern forest tree improvement conference; 1982 July 7-9; Durham, NH. Durham, NH: University of New Hampshire; 1983: 126-133.

Variation in susceptibility of 21 geographic seed sources of eastern white pines to white-pine weevil attacks over an 11-year period in a southern Maine provenance test plantation was examined. Trees from southern and western sources were among the most heavily weeviled but there also was stand-to-stand variation within states. Seed collections from weevil-resistant stands could be used for reforestation of white pine in high-risk areas of New England.

Wilkinson, Ronald C. **Leader and growth characteristics of eastern white pine associated with white pine weevil attack susceptibility.** Canadian Journal of Forest Research. 13(1): 78-84; 1983.

Seven morphological and growth characteristics of 208 eastern white pine leaders, measured when the trees were 22 years old, along with heights and diameters were examined in relation to susceptibility to white-pine weevil attack.

Willis, Raymond B.; Mullins, Gregory L. **Automated analysis for water alkalinity.** Analytical Chemistry. 55(7): 1175-1176; 1983.

The automated method for determining alkalinity has been modified to enable measurement of concentrations from 10 to 500 mg/l of CaCO_3 . Previous automated methods did not allow measurements below 100 mg/l. Results obtained with two automated instruments and the manual titration method were compared.

Wilson, C.; Shigo, A. L.; Pusey, A. **Long live the peach tree.** American Fruit Grower. 1983 February: 22-24.

Wood, Robert E.; Wargo, Philip M. **Biological evaluation. Rate of decline of Rio Grande cottonwoods subjected to flood plain aggradation and other environmental stresses.** Albuquerque, NM: U.S. Department of Agriculture, Southwestern Region, State and Private Forestry, Forest Pest Management; 1982; For. Pest Mgmt. Rep. R-3 83-4. 6 p.

Rio Grande cottonwoods growing in the wash running through the Chaco Canyon in Chaco Culture National Historical Park, New Mexico, were examined in September of 1982 to determine the extent of dieback and decline caused presumably by a late spring frost in May 1980. Excavation and observation indicated that flood plain aggradation in the wash is continually burying the roots of the tree creating an unfavorable environment for growth and reproduction of the trees. Dieback of the trees had been occurring since at least the mid 1970's and was accelerated, not caused, by the spring freeze in 1980. Except for a few scattered individuals the stand will be dead by 2000 AD; it can only be maintained by artificial regeneration.

Yaussy, D. A.; Brisbin, R. L. **Multivariate regression model for predicting lumber grade volumes of northern red oak sawlogs.** Res. Pap. NE-536. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

A multivariate regression model was developed to predict green board-foot yields for the seven common lumber grades processed from northern red oak factory logs. The model may be modified to predict various combinations of lumber grades.

Yawney, Harry W. **Planting sugar maple.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 53-60.

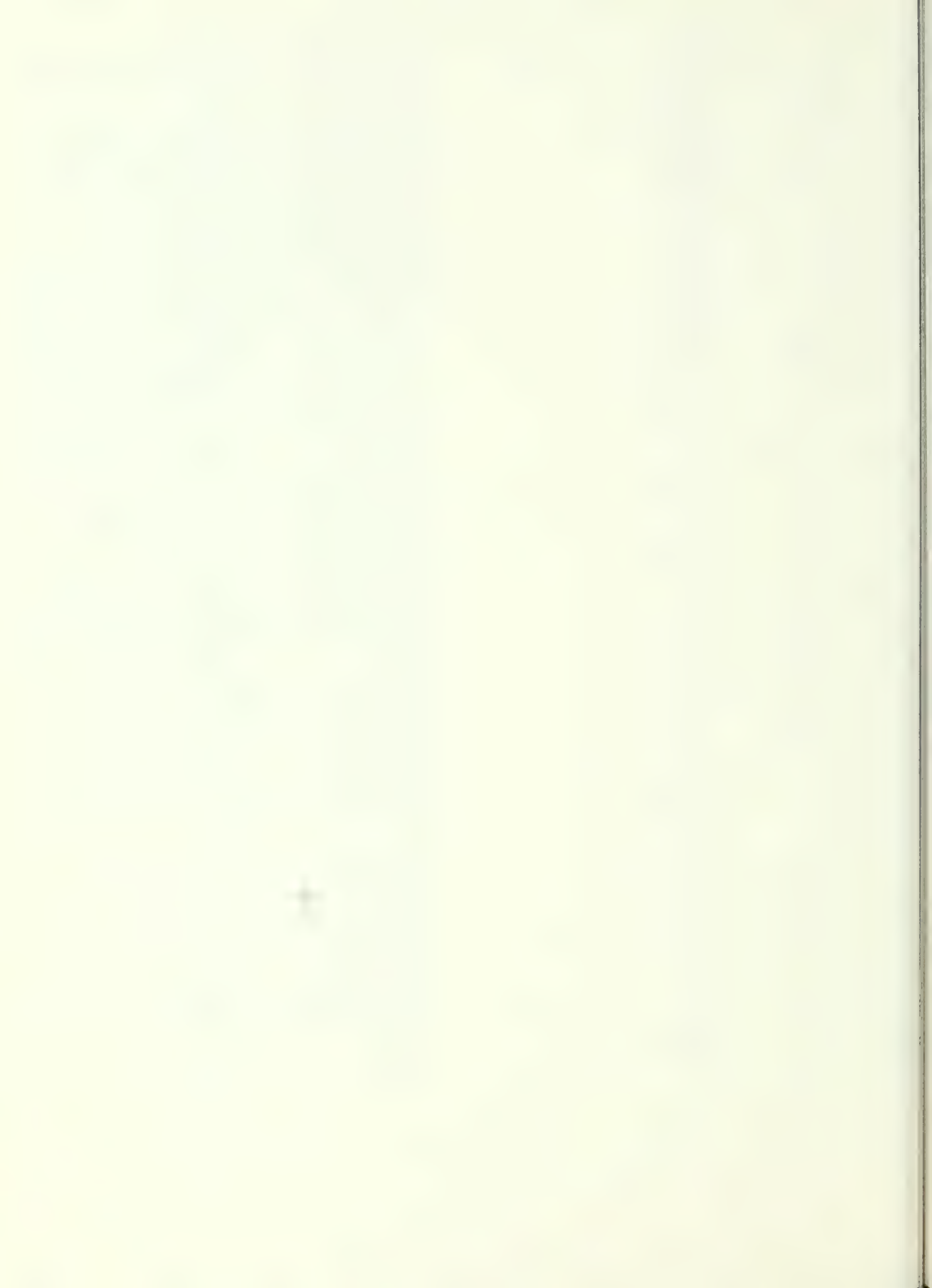
Discusses conditions for planting sugar maple on a suitable site with weed control and protection from animal damage.

Yawney, Harry W.; Donnelly, John R. **Rooting and overwintering sugar maple cuttings.** In: Sugar maple research: sap production, processing, and marketing of maple syrup. Gen. Tech. Rep. NE-72. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982: 61-70.

Discusses rooting sugar maple cuttings, which are the major emphasis in the Northeastern Forest Experiment Station's vegetative propagation program.

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Heisler, Gordon M.	University Park
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Rowntree, Rowan	Syracuse
Safford, Lawrence O.	Durham
Sanders, Ralph A.	Syracuse
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Northeastern Forest Experiment Station. **Publications of the
Northeastern Forest Experiment Station—1983.** Gen. Tech. Rep.
NE-103. Broomall, PA: U.S. Department of Agriculture, Forest
Service, Northeastern Forest Experiment Station; 1985. 41 p.

An annotated list of publications by Northeastern Forest Experiment
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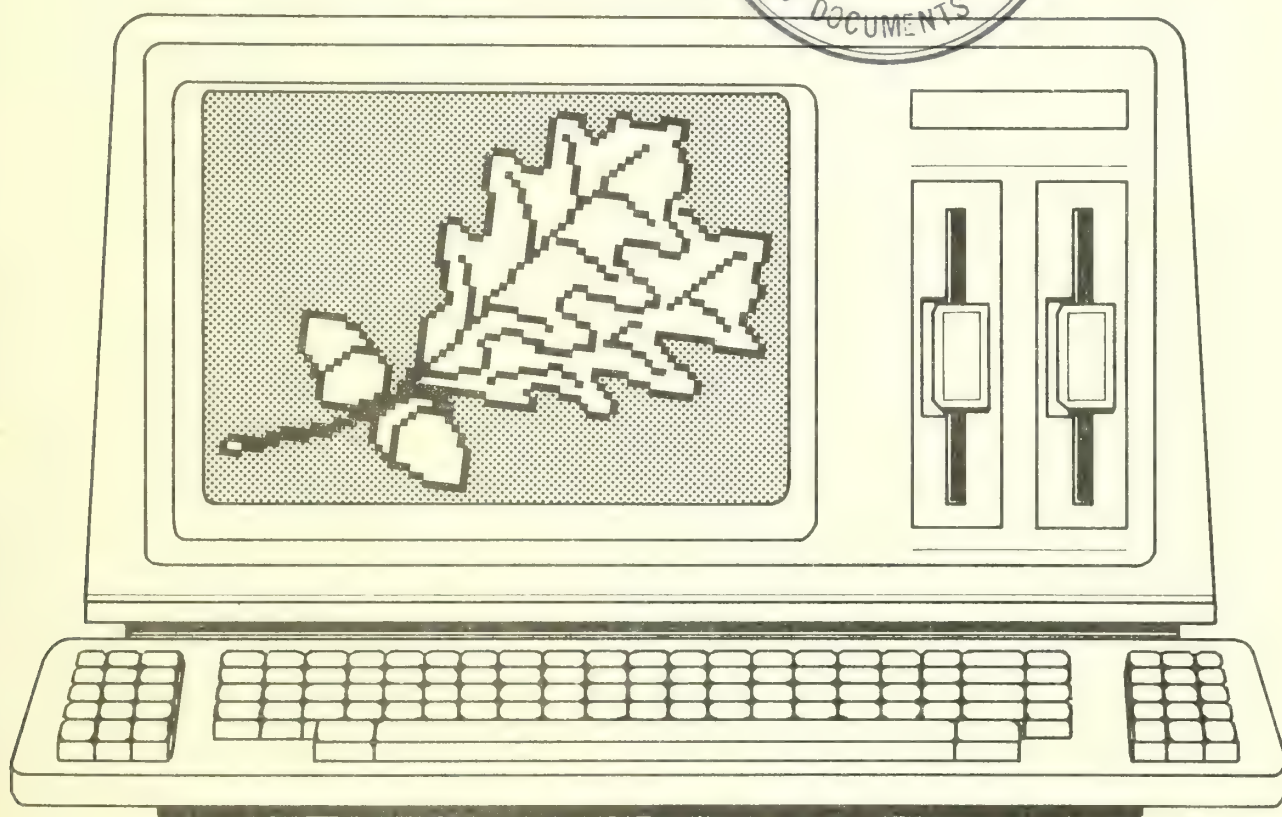
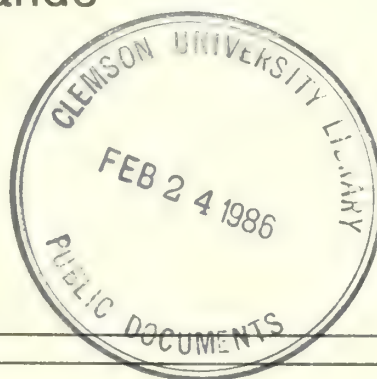
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User's Guide to OAKSIM

An Individual-Tree Growth and Yield
Simulator for Managed, Even-aged,
Upland Oak Stands

Donald E. Hilt



The Author

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Abstract

This user's guide presents operating instructions for OAKSIM, an individual-tree growth and yield simulator for managed, even-aged, upland oak stands. OAKSIM can make growth and yield projections for various thinning alternatives for up to 50 years. The general structure and operation of OAKSIM, program control information, data formats, program output, and examples of thinned and unthinned projections are included.

Note:

The computer program described in this publication is available on request with the understanding that the U.S. Department of Agriculture cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program. For cost information write Donald E. Hilt, Forestry Sciences Laboratory, USDA Forest Service, Northeastern Forest Experiment Station, 359 Main Road, Delaware, OH 43015.

The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

This version of OAKSIM represents an initial effort to give users a functional individual-tree growth and yield simulator for managed, even-aged, upland oak stands. Improvements to OAKSIM will continue. A comprehensive statistical validation of growth and yield projections will be made when an improved mortality model and an ingrowth model are completed. A method of projecting individual-tree quality changes in relation to residual stocking following intermediate thinnings will also be incorporated into OAKSIM. Information on tree quality is essential input to an economics subroutine that will be added to determine optimum management alternatives in the upland oak timber type.

Users are encouraged to submit useful changes, suggestions, or identified errors to the author for the next version of OAKSIM. OAKSIM can become a valuable tool for forest managers only through close cooperation and coordination between researchers and users.

Introduction

OAKSIM is an individual-tree growth and yield simulator for managed, even-aged, upland oak stands. Although no simulator can make final decisions, OAKSIM, if used properly, is a powerful quantitative tool that will assist forest land managers in the evaluation of various management alternatives for the nearly 109 million acres of upland oak timber type. This initial version of OAKSIM is designed to help managers evaluate management alternatives related to that silvicultural practice most likely to influence tree and stand growth and yield—intermediate thinning. The timing, intensity, and frequency of intermediate thinnings for a wide range of age, site, and stocking conditions can be studied in detail with OAKSIM.

Growth and yield projections for various thinning alternatives can be made with OAKSIM for periods of up to 50 years. And, since OAKSIM grows trees individually, projected stands can be partitioned into various species and size classes. This information is critical for determining the value of trees in the projected stand, an essential ingredient for evaluating the economic aspects of thinning, especially in hardwood stands.

OAKSIM is written in FORTRAN and designed to operate with maximum flexibility on a mainframe computer. The development and structure of the simulator, including all pertinent mathematical models, have been described in a companion publication (Hilt 1985). The objective of this user's guide is to provide users with the instructions necessary to operate the simulator. A brief explanation of how the program works, program applications, and an example are also included. Even though OAKSIM can be used to make growth and yield projections for a single stand, a more logical (and less expensive) approach is to develop management guidelines by exercising the simulator for broader categories of age, site, and stand conditions.

Program Structure

A generalized flow chart of the programming logic used in OAKSIM is shown in Figure 1. A series of control cards govern the following: (1) type of input data, (2) timing, intensity, and frequency of thinning, (3) tree volume calculations, and (4) type of output. If a stand table is provided in lieu of a tree list, OAKSIM generates a tree list as described later. A summary of initial stand conditions by species and size classes is then computed and printed. The stand may be thinned initially or at any 5-year interval to a specified stocking level. A maximum of ten 5-year growth projections may be made. The 5-year intervals provide adequate resolution of growth and yield projections over time for most users. Linear interpolation may be used for estimates between the 5-year intervals.

Diameter growth of each residual tree is predicted for each 5-year period. The probability of mortality for each tree is then determined from this diameter growth, the initial d.b.h. of the tree, and the species of the tree. If the tree is classified as dead on the basis of this probability and a draw from a random number generator, it is removed from the list. If the net stand basal area growth is not within stand-level growth limitations, a modifier is applied to the diameter growth calculations and the 5-year growth cycle is repeated.

Inside- and outside-bark volumes to specified top diameters are calculated for individual trees from predicted total tree height, the appropriate bark ratio equation, and a taper-based volume system. Stand and stock tables by species and size classes are printed after each 5-year interval for the initial stand, thinned trees, residual stand, mortality trees, and projected stand. A stand-level summary is printed for each stand after all 5-year projections have been completed. This summary is useful for comparing overall thinning strategies.

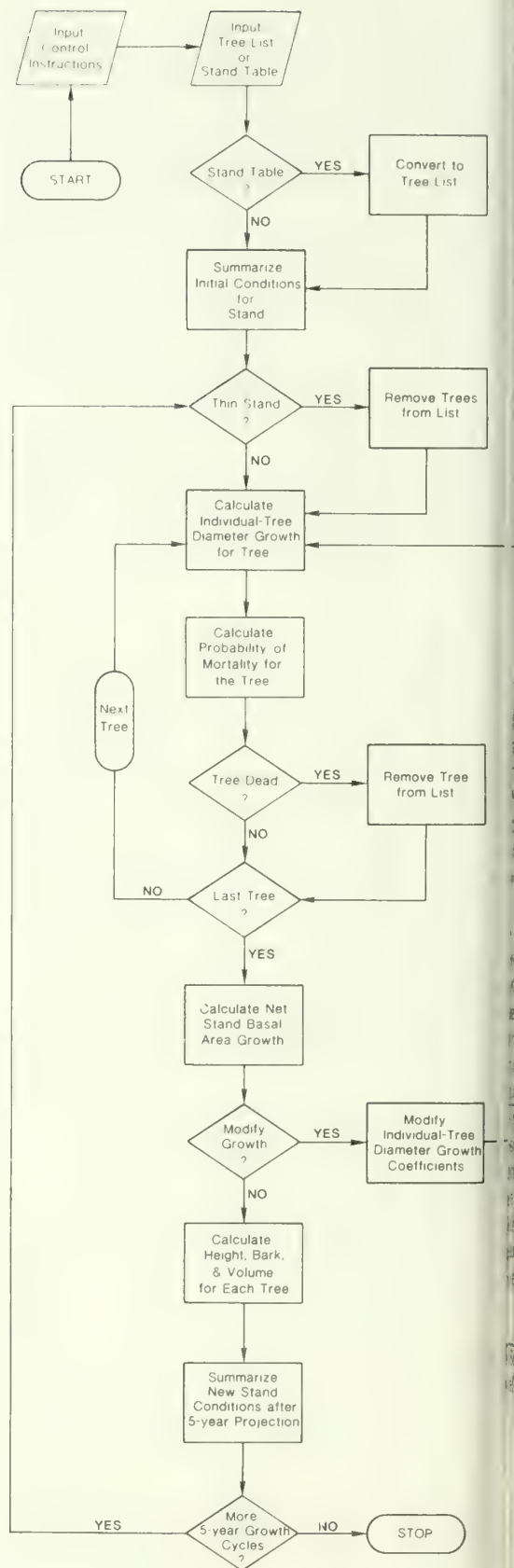


Figure 1.--Generalized flowchart of OAKSIM's operation.

Common Applications

OAKSIM can be applied to a wide range of stand, and site conditions. Like all simulators, however, OAKSIM has limitations, imposed primarily by the data bases used to construct the growth and yield models. Users must be cautious not to exceed these limitations, because erroneous projections can result. OAKSIM applications are limited to the following conditions:

Even-aged upland oak stands only

Oak component at least 75 percent of stand basal area

Stand age 30 to 120 years

Black oak site index 50 to 85

Percent stocking 20 to 120 percent

Tree d.b.h. 2.6 inches and larger

Maximum 50-year projection

OAKSIM should be applied only to those stands composed primarily of oak species found on upland sites: white,¹ black, scarlet, and chestnut. The simulator is not intended to be used on stands where northern red oak is the major oak component. Application to stands where the northern red oak component is less than 15 percent of the stand basal area, however, is permissible.

Stand structure should not differ radically from even-aged structures normally found on upland oak stands. Initial starting ages may range from 30 to 100 years. If the simulator is started at age 100, then projections should only be made for 20 years to the maximum 120 years. The simulator should not be used over. For example, if projections are made from ages 30 to 80, resulting output should not be used as input for a projection from ages 80 to 120. The program will terminate and error messages will be printed if a tree d.b.h. is less than 2.6 inches, or if stand age or site index fall outside their respective ranges of application. The user is responsible for verifying the other conditions.

¹Little (1978) for scientific names of all species referred to in this paper.

Control Cards

General Information

The 13 types of control cards used in OAKSIM guarantee maximum flexibility to meet user needs. A wide range of species and size class groupings is permissible. Merchantability standards are also user-specified. Except for thinning specifications, the control cards are unlikely to be altered for subsequent computer runs for a given stand or set of stands. Frequent changes in species group, size class, and merchantability designations would most likely confuse the analysis of the various simulation runs.

Quick-reference descriptions, formats, and default values for all control cards appear in Table 1. The appropriate number of control cards, as indicated in Table 1, must appear in the program setup for proper execution. If default values are desired, simply insert a blank card as necessary.

Card Type 1

The type of input data is specified on Card Type 1. A value of 1 indicates that data is in the form of a tree list; a value of 2 indicates stand table data. Information to appear on the data cards and appropriate data formats for both options are described later in the Data section.

OAKSIM is designed to operate from a tree list containing the species and d.b.h. of each tree in the stand, but users seldom have access to a complete list of trees in a stand, except perhaps in research situations. A stand table input option, therefore, is included in OAKSIM to make the simulator more compatible with practical applications. The number of trees in each size (d.b.h.) and species (or species group) class must be specified with the stand table option. Size classes may be either 1- or 2-inch d.b.h. classes. A random number generator is called on to distribute the d.b.h.'s of trees in each species and size class uniformly across the d.b.h. class. For example, if there are 25 white oak trees in the 6-inch d.b.h. class (a 1-inch d.b.h. class), the generated tree list will include 25 white oak trees uniformly distributed from 5.55 to 6.54 inches. (This range is used because trees are placed in appropriate d.b.h. classes within the program by adding 0.45 to the tree d.b.h., and then rounding to the last full integer value.) Initial growth projections are then based on this generated tree list. This approach provides a close approximation to the actual distribution of trees across d.b.h. classes.

Table 1.—Control cards for OAKSIM. All values must be right-justified in appropriate columns.

Card type	Number of cards	Information on card	Columns	Format ^a	Default values
1	1	Type of input data: 1=tree list 2=stand table	1	I1	
2	1	Stand number Stand age Site index	1-3 4-6 7-8	I3 F3.0 F2.0	
3	1	Number of species groups. Maximum is 5.	1	I1	
4	1 for each species group ^b	Species group ID: (1,2,3,4, or 5)	1	I1	
		Number of species codes in species group	3-4	I2	
		Height group code: 1=white oak 2=black oak	6	I1	
		Mortality group code: 1=white oak 2=black oak 3=other commercial trees 4=noncommercial trees and shrubs	8	I1	
		Average DBHIB/DBHOB ratio (RBAR)	10-12	F3.2	0.91
		Average BO	14-17	F4.3	0.0
		Average B1	19-22	F4.3	0.0
		Species codes in group ^b . Maximum of 11 codes for each group	26-30, 31-35, etc.	11I5	

Continued

Table 1.--Continued

Card type	Number of cards	Information on card	Columns	Format ^a	Default values
5	1	Number of top d.i.b.'s for cubic volume. Maximum is 2.	1	I1	2
		Top d.i.b.'s for cubic volume. List in descending order.	2-3, 4-5	2F2.0	4.,0.
6	1	Number of top d.i.b.'s for BF volume. Maximum is 2.	1	I1	2
		Top d.i.b.'s for BF volume. List in descending order	2-3, 4-5	2F2.0	10.,8.
7	1	Minimum log length, cubic volume	1-4	F4.1	4.0
		Minimum log length, BF volume	5-8	F4.1	8.0
8	1	Maximum d.b.h. for saplings	1-5	F5.2	4.55
		Maximum d.b.h. for poles	6-10	F5.2	11.55
9	1	Size of d.b.h. classes: 1=1 inch 2=2 inch	1	I1	1
10	1	Number of 5-year projections. Maximum is 10.	1-2	I2	10
11	1	Number of thinnings	1-2	I2	0
		Thinning intensity for each species group	3-4, 5-6, etc.	5(I2)	0
12	1 for each time thinning occurs	Age at thinning (must be 5-year increment of initial stand age)	1-3	I3	
		Percent stocking to leave	4-6	F3.0	

Continued

Table 1.--Continued

Card type	Number of cards	Information on card	Columns	Format ^a	Default values
13	1	Print specifications: 0=initial and ending stand/stock tables 1=intermediate stand tables also printed 2=intermediate stock tables also printed 3=intermediate stand and stock tables also printed	1	I1	0

^aFormat for entire card is combination of formats for each element of information on card, except Card Type 4, which has a complete format of (I1, 1X, I2, 1X, I1, 1X, I1, 1X, F3.2, 1X, F4.3, 3X, 11I5).

^bOn Card Type 4, species codes for the last species group do not have to be listed. All species codes not listed previously are placed in the last species group. All other information for the last species group, however, must be specified.

Card Type 2

A stand identification number (up to three digits, assigned by the user, that will appear on the printout), stand age, and black oak site index appear on Card Type 2.

Stand age is the average total age of the dominant/codominant trees in the even-aged stand determined from increment borings. Total age for upland oaks is equal to the breast-height age plus 2 years. Black oak site index is determined in the traditional manner with available site index curves for upland oak stands (Schnur 1937; Carmean 1971; McQuilkin 1974). If black oak trees are not present in the stand, a general rule of thumb for converting to black oak site index is: black oak site index equals white oak site index plus 3, chestnut oak site index plus 2, northern red oak site index plus 1, or scarlet oak site index minus 1. More precise conversion factors can be found in the literature (McQuilkin 1974; Carmean and Hahn 1983; McQuilkin 1985).

Card Type 3

The number of species groups to be used is specified on Card Type 3. A maximum of 5 groups is permitted.

Card Type 4

Card Type 4 is the most complex control card. Information governing the species group assignment, height and bark codes for volume calculations, and mortality codes are included on this card. The card can be completed fairly simply, however, with a little practice. And, once the cards are completed, they are not likely to be changed frequently. One card must be completed for each species group.

Species group ID.--A numerical code of 1, 2, 3, 4, or 5, located in column 1, identifies the species group.

Number of species codes in species group.--A maximum of 11 species codes can be placed in each species group.

Table 2.—Recommended values of height group codes, mortality group codes, average DBHIB/DBHOB ratios (RBAR), and bark equation coefficients (B0 and B1) for species that occur frequently in the upland oak timber type.

Species	Height group code	Mortality group code	DBHIB/DBHOB ratio (RBAR)	Average B0 value	Average B1 value
<u>Oaks</u>					
White oak	1	1	0.91	0.881	0.056
Black oak	2	2	.90	.832	.103
Scarlet oak	2	2	.90	.832	.103
Chestnut oak	1	1	.88	.774	.149
Northern red oak	2	2	.90	.864	.084
Southern red oak	2	2	.90	.888	.040
Post oak	1	1	.91	.0	.0
<u>Associated Commercial Species</u>					
American beech	1	3	.95	.0	.0
Ash	2	3	.90	.0	.0
Basswood	2	3	.92	.0	.0
Black cherry	2	3	.94	.0	.0
Black walnut	2	3	.90	.0	.0
Hickory	1	3	.90	.0	.0
Red maple	1	3	.95	.919	.045
Sugar maple	1	3	.92	.873	.060
Yellow-poplar	2	3	.90	.840	.087
Other	1	3	.90	.0	.0
<u>Noncommercial Species and Shrubs</u>					
All	1	4	.90	.0	.0

Height group code.—OAKSIM assigns total tree heights to trees with height prediction equations for either white oak (height group code 1) or black oak (height group code 2). Since height prediction equations are not presently available for other species, recommended height group codes for most species found in the upland oak type are listed in Table 2.

The user must exercise some discretion in assigning height codes to the species groups. If the species group is composed only of white oaks, then the code is obviously 1. But if the species group contains species from both height groups, use the height group code that applies to the majority of

the trees in the species group. Make a sensible assignment of the height group code to each species group, but do not spend inordinate amounts of time trying to determine height group codes scientifically: an incorrect assignment does not alter volume calculations substantially.

Mortality group code.—Each species group must be assigned one of four mortality codes: (1) white oak, (2) black oak, (3) other commercial trees, or (4) noncommercial trees and shrubs. Recommended mortality group codes for most species are listed in Table 2.

Like height group codes, mortality group codes require some discretion in assignment when species with different mortality groups are mixed in a species group. Again, use the code that applies to the majority of the trees in the species group. A distinct mortality group code will usually apply to a normal breakdown of species groups.

Average DBHIB/DBHOB ratio (RBAR).—OAKSIM uses the RBAR value in calculating inside- and outside-bark volumes. RBAR values can be determined in two ways: by actual field sampling, or by using the recommended values in Table 2. The recommended values are based on previously-reported research studies and also on my experience in the upland oak type. Actual field sampling is preferred if OAKSIM is run for a particular stand of interest. The RBAR for the species group is the average of the RBARs for all trees in the group. An approximate value for the species group is satisfactory since errors in the determination of RBAR are not too serious—perhaps only 1 or 2 percent of tree volumes. When in doubt, use the RBAR value for the predominant species in the group. A default value of 0.91 is supplied by OAKSIM.

Average B0, B1.—Every effort is made in OAKSIM to estimate tree volumes accurately. The d.i.b./d.o.b. ratios for most hardwoods either remain constant or decrease up the stem (Hilt et al. 1983). B0 and B1 are model coefficients that govern volume calculations for species that have decreasing d.i.b./d.o.b. ratios. Recommended values for B0 and B1 are listed in Table 2. The B0 and B1 values for the species group are the averages of the B0 and B1 values for all trees in the group. Again, approximate values are satisfactory because small errors in B0 and B1 only affect volume estimates by about 1 percent. When in doubt, use the B0 and B1 values for the predominant species in the group. Default values of 0.0 are supplied by OAKSIM for both B0 and B1. Values of 0.0 indicate that the d.i.b./d.o.b. ratio, RBAR, remains constant up the stem.

Species codes in group.—User-specified codes for each species group eliminate the need for users to adhere to any prespecified codes for various species. A maximum of 11 species codes (up to 5 digits) are listed in columns 25-80. Species codes do not have to be listed for the last species group. All codes not listed for previous groups are placed in the final group. I usually delineate three or four key species groups, then let the program automatically place all other codes in the final miscellaneous group. All other information on Card Type 4, however, must be specified for the last group.

Card Types 5 and 6

A taper-based volume system used in OAKSIM allows users to specify a wide range of merchantability standards. Virtually any top d.i.b.'s may be specified. A maximum of two top d.i.b.'s can be specified for cubic-foot volumes on Card Type 5, and two top d.i.b.'s for International 1/4-inch board-foot volumes on Card Type 6. The top d.i.b.'s must be listed in descending order, e.g., 10-inch top, then 4-inch top. Both inside- and outside-bark volumes are computed to the specified tops for cubic-foot volume. Default values are 4.0 and 0.0 inches for cubic volumes, and 10.0 and 8.0 inches for board-foot volumes.

Card Type 7

Minimum log lengths for cubic and board-foot volume calculations are specified on Card Type 7. If a tree does not have at least the minimum log length to a specified top diameter, no volume is computed to that top d.i.b. for that tree. Fractional log lengths are included in volume computations, however, if the tree meets minimum requirements. For example, if the minimum log length for cubic volume is specified at 4 feet and the top d.i.b. at 4.0 inches, no volume would be calculated for a tree that has a 4-inch top at, say, 3.9 feet. If the 4-inch top occurred at 7.9 feet, however, volume would be computed for the entire 7.9 feet. The same rule applies to board foot calculations. A specified top d.i.b. of 0.0 inches always results in the calculation of total stem cubic volume, unless an exceptionally long minimum length such as 15 feet is specified. Default values are 4.0 feet for cubic-foot volumes, and 8.0 feet for board-foot volumes.

Card Type 8

Product size classes for saplings, poles, and sawtimber are specified on Card Type 8. The minimum d.b.h. for poletimber is entered in columns 1 to 5, and the minimum d.b.h. for sawtimber is specified in columns 6-10. Follow this simple rule to set threshold diameters: (1) decide on the minimum d.b.h. of the product size class, to the nearest 1/10 inch, (2) subtract 0.05, and (3) enter resulting value on card. The default value for minimum d.b.h. of the poletimber class is $4.6 - 0.05 = 4.55$ inches. The default value for minimum d.b.h. of the sawtimber class is $11.6 - 0.05 = 11.55$ inches.

Card Type 9

The size of d.b.h. classes is entered on Card Type 9. A value of 1 indicates 1-inch classes, and a value of 2 indicates 2-inch classes. If the tree list input option (see Card Type 1 and Data section) is used, the d.b.h. class designation will control output only. If the stand table input option is used, d.b.h. class designations must coincide with the d.b.h. classes of the stand table because this card will then control both the creation of the tree list and the output. A default value of 1 is provided.

Card Type 10

The number of 5-year projections to be made with OAKSIM is listed on Card Type 10. A maximum of ten 5-year projections is allowed. A default value of 10 is provided.

Card Type 11

The number of thinnings to be made and the thinning intensity for each species group appears on Card Type 11. A thinning may be made at the beginning of each of the 10 projection periods if desired.

The thinning rule used in OAKSIM makes every attempt to duplicate the actual thinning method applied by professional foresters on the growth and yield plots used to develop the simulator. The thinning method used is best described as "free thinning"—the marker was free to remove trees from all crown classes. The objective was to leave the specified stocking level distributed on the best trees as evenly spaced as possible throughout the plot. In general, the larger cull and defective trees were cut first, then the competing trees of poor form and quality, then the intermediate and suppressed trees of lower quality and value. Finally, if necessary, lower value species and even some high-quality desirable species were removed from the main canopy to achieve a uniform spatial distribution. In essence, this thinning method represents the most realistic, practical thinning method that can be applied at the present time by professional foresters in even-aged upland oak stands.

OAKSIM is one of the few simulators that uses a thinning rule based on actual data, not artificial rules governed only by computer programming. Until additional plots can be established to study other thinning methods in upland oak stands, such as thinning strictly from above or below, this thinning rule should be used because the growth models are based on this thinning method. There is, however, some flexibility with OAKSIM: three options are available to control the intensity of cut across species groups within a d.b.h.

class: (1) a code value of 0 maintains the same proportion of species as the unthinned stand, (2) a value of 1 doubles the allocated cut for specified species groups, and (3) a code equal to 2 eliminates a species group entirely. Only minor species groups such as understory species should be eliminated with the third option. Major species groups such as white oak or black oak should not be eliminated.

Card Type 12

The age of thinning and the desired percent stocking to leave after thinning are specified on Card Type 12. There must be one card for each time the stand is thinned (see Card Type 11 for number of thinnings). The age at thinning must be a 5-year increment of the initial stand age listed on Card Type 2. Residual stocking may range from 20 to 120 percent.

Card Type 13

The code on Card Type 13 controls printing during the program output phase. Information on projected stands is comprehensive. Stand tables are listed by specified d.b.h. classes and species groups. Stock tables are listed by product size classes (see Card Type 8) and species groups. And the information on growth components is listed in a logical order: initial stand conditions, cut trees, residual stand, mortality trees, and projected stand. A numerical code from 0 to 3 controls output as follows:

<u>Code</u>	<u>Output</u>
0	Initial and ending stand and stock tables only.
1	<u>Stand tables</u> for all growth components at all intermediate ages are also printed.
2	<u>Stock tables</u> for all growth components at all intermediate ages are also printed.
3	<u>Stand and stock tables</u> for all growth components at all intermediate ages are also printed. This option generates the most comprehensive output.

In addition to stand and stock tables, a comprehensive summary table for the entire growth and yield simulation run is always printed. Although there is no breakdown by species and size classes in this table, the summary provides an excellent overview of the simulation run and is most valuable for examining the effects of various thinning alternatives.

Data Cards

General Information

As defined on Control Card Type 1, data may be entered as either a tree list or a stand table. Both methods of data entry must represent trees on a per-acre basis. Since OAKSIM does not make any provision for converting data collected from various field sampling schemes to a per-acre basis, the user is responsible for the construction of the appropriate list or stand table. Quick-reference descriptions and formats for data cards appear in Table 3.

Tree List

One data card is required for each tree in the stand. The species code is any integer value, up to five digits long, that the user desires. OAKSIM uses the species codes to assemble trees into species groups, as defined on Control Card Type 4. The d.b.h. of each tree is entered on the data card without a decimal point, but read by an F4.1 format because diameters of trees in a list are usually measured to the nearest 1/10 inch. For example, a 10.8-inch tree would be entered as 108, and a 3.0-inch tree as 30, right justified. If the d.b.h.'s of trees in the list are measured to the nearest inch rather than the nearest tenth inch, enter a 0 for the tenths. For example, a 10-inch tree would be entered as 100, and a 3-inch tree as 30.

Stand Table

One card is required for each species code and d.b.h. class used in the stand table. Species codes, like those used in the tree list, are integer values up to five digits long. Any number of species codes may be used in the input data. OAKSIM will group the codes later according to the information specified on Control Card Type 4. The midpoint of each d.b.h. class (either a 1- or 2-inch class) is specified as a two-digit code without a decimal point, and read by an F2.0 format. The number of trees in each species code by d.b.h. class is an integer value up to three digits long. If there were 27 trees in the 10-inch d.b.h. class, species code 710, the data card would appear as 71010 27.

Random Number Generator

A random number generator is used in OAKSIM to convert stand tables to tree lists and to calculate individual-tree diameter growth rates and probabilities of mortality. The CALL statements in OAKSIM used to invoke the random number generator are based on local computing commands, and will require some modification by the user. The generator used in OAKSIM is almost identical to IBM's RANDOM Subroutine Package. If RANDOM or its local counterpart are not available, users are advised to use a well-tested random number generator.

Table 3.—Data cards for OAKSIM. All values must be right-justified in appropriate columns.

Number of cards	Information on card	Columns	Form
<u>Tree list</u>			
One for each tree	Species code Tree d.b.h.	1-5 6-9	IS F
<u>Stand table</u>			
One for each species code and d.b.h. class used.	Species code D.b.h. class Number of trees	1-5 6-8 9-11	IS F IS

^aFormat for entire data card is combination of format for each element of information on card.

Use of random numbers makes OAKSIM a stochastic simulator. Output is somewhat dependent on the random numbers generated and can be altered by changing the seed used to initialize the generator (although this is not recommended). The seed statement in OAKSIM is IX = 111111. Testing has revealed that changing the seed, and hence the sequence of random numbers, varies output only slightly, especially if long projections such as 50 years are specified. Slight variations in output reflect only the natural variation inherent in the complex growth and yield of a forest stand.

Example Using Oaksim

Program control cards and data used for this sample run of OAKSIM appear in Table 4. Initial conditions for the 30-year-old upland oak stand are the same as those for the "average" normal stand described in Schnur's (1937) yield and stand tables. Site index is 70.

Stand table data were segregated into four species groups: (1) white and chestnut oaks, (2) black and scarlet oaks, (3) red maple and dogwood, and (4) hickory, yellow-poplar, and red elm. Species codes are those used regularly in our collection of research data. Height and mortality group codes were readily determined from Table 2. For example, mortality group code 3 was assigned to species group 3 because it contained more red maple than dogwood.

TABLE 4.--Data cards for sample run of OAKSIM.

1	2	3	4	5	6	7	8
2	TYPE OF INPUT DATA						
1 3070	STAND NUMBER,AGE,&SITE						
4	NUMBER OF SPECIES GROUPS						
1 2 1 1 091 0881 0056	01	04					
2 2 2 2 090 0832 0103	02	03					
3 2 1 3 093 0919 0045	18	23					
4 3 1 3 090 0000 0000							
2 4 0	CUBIC VOLUME TOP DIBS						
2 8 5	BDFT TOP DIBS						
4.0 16.0	MINIMUM CUBIC & BDFT LENGTHS						
4.55 8.55	SAPD,POLED						
1	DCLASS SIZE 1 OR 2 INCHES						
10	NUMBER OF PROJECTIONS						
1 0 0 0 0	NUMBER THINNINGS & THINLV						
30 40	AGE & PS OF THINNING						
1	PRINT OPTIONS						
1 3 59	2	3	4	5	6	7	8
1 4 69							
1 5 51							
1 6 31	White Oak						
1 7 14							
1 8 6							
1 9 3							
2 3 15							
2 4 27							
2 5 42							
2 6 35	Black Oak						
2 7 20							
2 8 12							
2 9 5							
2 10 3							
3 3 7							
3 4 20							
3 5 20							
3 6 19	Scarlet Oak						
3 7 12							
3 8 5							
3 9 2							
4 3 10							
4 4 9							
4 5 8	Chestnut Oak						
4 6 7							
4 7 2							
10 3 2							
10 4 2	Yellow-Poplar						
12 3 10							
12 4 2							
12 5 1	Hickory						
12 6 1							
18 3 10							
18 4 10							
18 5 13							
18 6 7	Red Maple						
18 7 4							
18 8 2							
18 9 1							
23 3 13							
23 4 9	Dogwood						
32 3 1							
32 4 1	Red Elm						

Assignment of the RBAR, B0, and B1 values to various species groups for bark calculations requires some judgement by the user. However, since these values are not critical for the execution of OAKSIM, make reasonable assignments and proceed without worry. I used white oak values for species group 1 because white oak is the predominant species in the group. Black and scarlet oak in group 2 have identical values. I used red maple B0 and B1 values for species group 3 because red maple is the predominant species. The RBAR value, however, was lowered slightly from 0.95 to 0.93 by the presence of dogwood in the group. Values for hickory were used for group 4 because it is the predominant species.

Cubic-foot volumes are specified to be calculated to a 4-inch top d.i.b. and also total stem (0.0-inch top). The tree must have at least 4 feet to the specified top d.i.b. for volume to be calculated.

International 1/4-inch board-foot volumes are specified to be calculated to 8- and 5-inch tops. Each tree must have at least a 16-foot log to the top d.i.b. Also, all trees greater than 8.55 inches will fall into the sawtimber size class. These specifications were used so that board-foot yields could be compared to Schnur's (1937) yield tables. Larger top d.i.b.'s and a threshold d.b.h. of 11.55 inches would be more common for sawtimber.

One-inch d.b.h. size classes are specified for the input data, and ten 5-year projections are requested. One thinning to 40 percent residual stocking at age 30 is specified. Thinnings will leave approximately the same proportion of trees for each species group in every d.b.h. class as were in the initial stand, since zero codes were specified for all groups. The print code was set equal to 1 so that all intermediate stand tables would be printed.

Bracketed numbers that follow in this section refer to annotations on the OAKSIM output in Tables 5 and 6. Output for the thinned stand appears in Table 5. Only the final summary table of the unthinned OAKSIM run for the same stand is shown in Table 6.

OAKSIM always prints out a summary of all control card information [1]. The initial stock table for age 30 [2] includes a comprehensive breakdown by species groups and product size classes for all major stand characteristics. Average d.b.h. values [3] listed in the stock tables are arithmetic means, not quadratic. The initial stock and stand [4] tables are always printed. Since all intermediate stand tables were requested for this run of OAKSIM, stand tables for trees removed in thinning [5], residual trees after thinning [6], mortality trees [7], and trees in the projected stand [8] for all 5-year intervals are printed (only those to age 35 are listed in Table 1). Final stand [9] and stock [10] tables are always printed.

It is evident from [5] that the majority of the 399 trees removed with the thinning rule were in the lower crown classes. Nearly 91 percent of the trees in the 3-inch d.b.h. class were cut. Some of the largest trees, however, were also removed. These larger trees are representative of the larger cull and rough trees often found in upland oak stands. The percentage of trees by species group in each d.b.h. class, as specified by the control cards, remained nearly the same after thinning. For example, the 38 trees in the white oak group accounted for 38 percent of the 100 trees in the 6-inch d.b.h. class before thinning, and the 20 residual trees accounted for 39 percent of the 51 trees in the 6-inch class after thinning.

All of the detailed information available in the stand and stock tables must be utilized for a comprehensive evaluation of various thinning regimes. The size and species determine the value of a tree. For example, the changes that occurred in the white oak group should be examined closely because of the high value of this species relative to the other three groups. On the other hand, the final summary table [11,12] provides a good overall look at stand development over the projection period and is most useful for narrowing the choices of various thinning regimes.

(Text continued on page 20)

TABLE 5

DATA TYPE AND STAND INFORMATION.

TYPE OF INPUT DATA: STAND TABLE
 NUMBER OF STANDS: 1

STAND NUMBER	AGE	SITE INDEX
1	30.0	70.0

1

HEIGHT AND BARK DATA.

SPECIES GROUP	HTGRP	RBAR	BO	B1
1	WO	0.910	0.881	0.056
2	BO	0.900	0.832	0.103
3	WC	0.930	0.919	0.045
4	WO	0.900	0.000	0.000

PROJECTIONS.

NUMBER OF 5-YEAR PROJECTIONS: 10
 FIRST & LAST STAND-STOCK TABLES ALWAYS PRINTED.
 ALL STAND TABLES PRINTED: YES
 ALL STOCK TABLES PRINTED: NO

VOLUMES TO BE CALCULATED.

	TOP DIAMETERS	
	---	-----
CUBIC VOLUME	4.0	0.0
BOARD FOOT VOLUME	8.0	5.0
MINIMUM LENGTH FOR CUBIC VOLUMES IS 4.0 FEET, AND 16.0 FEET FOR BD FT VOLUMES.		
PRODUCT SIZE CLASSES ARE 4.55 INCHES FOR POLES, AND 8.55 INCHES FOR SAWLOGS.		

SPECIES CODES.

SPECIES GROUP	SPECIES CODES	
---	-----	-----
1	1	4
2	2	3
3	18	23
4	ALL OTHER CODES ARE IN THIS GROUP.	

THINNING OPTIONS.

NUMBER OF THINNINGS: 1
 THINNING METHOD: FREE THINNING
 THINNING INTENSITIES BY SPECIES
 GROUPS: 0 0 0 0

AGE THINNED	PERCENT STOCKING
-----	-----
30	40.0

SUMMARY STAND STATISTICS: INITIAL CONDITIONS FOR STAND AT AGE 30.

SPECIES :	1	2	3	4	5	TOTALS
N TREES:						
SAP	147.0	69.0	42.0	18.0		276.0
POLE	119.0	165.0	26.0	2.0		312.0
SAW	3.0	10.0	1.0	0.0		14.0
TOTAL	269.0	244.0	69.0	20.0		602.0
BA:						
SAP	10.3	5.2	2.9	1.1		19.5
POLE	22.4	34.2	5.0	0.3		61.9
SAW	1.3	4.8	0.4	0.0		6.5
TOTAL	34.0	44.2	8.3	1.5		87.9
PS:						
SAP	14.1	7.0	4.0	1.6		26.6
POLE	24.1	36.0	5.4	0.4		65.8
SAW	1.2	4.3	0.4	0.0		5.9
TOTAL	39.4	47.3	9.7	2.0		98.4
AVG DBH:						
SAP	3.5	3.7	3.5	3.3		3.6
POLE	5.8	6.1	5.8	5.6		5.9
SAW	8.9	9.3	9.0	0.0		9.2
CVOB 4.0:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	349.3	574.3	81.9	4.9		1010.4
SAW	32.7	116.0	10.8	0.0		159.5
TOTAL	382.0	690.2	92.7	4.9		1169.9
CVIB 4.0:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	303.6	491.0	75.4	4.0		874.0
SAW	28.2	98.1	9.9	0.0		136.2
TOTAL	331.8	589.1	85.3	4.0		1010.2
CVOB 0.0:						
SAP	195.2	104.6	52.0	20.7		372.6
POLE	513.0	807.6	114.1	7.9		1442.6
SAW	35.1	124.3	11.5	0.0		170.9
TOTAL	743.3	1036.5	177.6	28.6		1986.0
CVIB 0.0:						
SAP	168.0	87.9	47.5	16.8		320.1
POLE	440.8	677.6	104.2	6.4		1229.0
SAW	30.2	104.4	10.5	0.0		145.1
TOTAL	638.9	869.9	162.2	23.2		1694.2
BFVOL 8.0:						
SAW	0.0	0.0	0.0	0.0		0.0
BFVOL 5.0:						
SAW	103.3	361.5	36.4	0.0		501.2

STAND TABLE: INITIAL CONDITIONS FOR STAND AT AGE 30.

DBH CLASS	SPECIES GROUPS					TOTALS
	1	2	3	4	5	
3	69.0	22.0	23.0	13.0		127.0
4	78.0	47.0	19.0	5.0		149.0
5	59.0	62.0	13.0	1.0		135.0
6	38.0	54.0	7.0	1.0	4	100.0
7	16.0	32.0	4.0	0.0		52.0
8	6.0	17.0	2.0	0.0		25.0
9	3.0	7.0	1.0	0.0		11.0
10	0.0	3.0	0.0	0.0		3.0
TOTALS	269.0	244.0	69.0	20.0		602.0

STAND TABLE: TREES REMOVED IN THINNING AT AGE 30.

DBH CLASS	SPECIES GROUPS					TOTALS
	1	2	3	4	5	
3	62.0	20.0	21.0	12.0		115.0
4	63.0	34.0	14.0	4.0		115.0
5	34.0	35.0	8.0	1.0		78.0
6	18.0	26.0	4.0	1.0		49.0
7	7.0	14.0	2.0	0.0	5	23.0
8	3.0	7.0	1.0	0.0		11.0
9	2.0	3.0	1.0	0.0		6.0
10	0.0	2.0	0.0	0.0		2.0
11	0.0	0.0	0.0	0.0		0.0
12	0.0	0.0	0.0	0.0		0.0
TOTALS	189.0	141.0	51.0	18.0		399.0

STAND TABLE: RESIDUAL STAND AFTER THINNING AT AGE 30.

DBH CLASS	SPECIES GROUPS					TOTALS
	1	2	3	4	5	
3	7.0	2.0	2.0	1.0		12.0
4	15.0	13.0	5.0	1.0		34.0
5	25.0	27.0	5.0	0.0		57.0
6	20.0	28.0	3.0	0.0		51.0
7	9.0	18.0	2.0	0.0		29.0
8	3.0	10.0	1.0	0.0	6	14.0
9	1.0	4.0	0.0	0.0		5.0
10	0.0	1.0	0.0	0.0		1.0
11	0.0	0.0	0.0	0.0		0.0
12	0.0	0.0	0.0	0.0		0.0
TOTALS	80.0	103.0	18.0	2.0		203.0

STAND TABLE: MORTALITY FOR GROWTH PERIOD BEGINNING AT AGE 30.

DBH CLASS	SPECIES GROUPS					TOTALS
	1	2	3	4	5	
3	1.0	0.0	0.0	0.0		1.0
4	0.0	0.0	0.0	0.0		0.0
5	0.0	0.0	0.0	0.0		0.0
6	0.0	0.0	0.0	0.0	7	0.0
7	0.0	0.0	0.0	0.0		0.0
8	0.0	0.0	0.0	0.0		0.0
9	0.0	1.0	0.0	0.0		1.0
10	0.0	0.0	0.0	0.0		0.0
11	0.0	0.0	0.0	0.0		0.0
12	0.0	0.0	0.0	0.0		0.0
TOTALS	1.0	1.0	0.0	0.0		2.0

STAND TABLE: INITIAL CONDITIONS FOR STAND AT AGE 35.

DBH CLASS	SPECIES GROUPS					TOTALS
	1	2	3	4	5	
3	4.0	2.0	2.0	1.0		9.0
4	5.0	5.0	3.0	0.0		13.0
5	16.0	14.0	4.0	1.0		35.0
6	22.0	23.0	2.0	0.0		47.0
7	15.0	24.0	4.0	0.0	8	43.0
8	11.0	12.0	2.0	0.0		25.0
9	4.0	12.0	1.0	0.0		17.0
10	2.0	8.0	0.0	0.0		10.0
11	0.0	1.0	0.0	0.0		1.0
12	0.0	1.0	0.0	0.0		1.0
TOTALS	79.0	102.0	18.0	2.0		201.0

STAND TABLE: INITIAL CONDITIONS FOR STAND AT AGE 80.

DBH CLASS	SPECIES GROUPS					TOTALS
	1	2	3	4	5	
6	0.0	0.0	0.0	0.0		0.0
7	2.0	2.0	1.0	0.0		5.0
8	7.0	1.0	2.0	0.0		10.0
9	10.0	4.0	2.0	0.0		16.0
10	12.0	10.0	2.0	0.0	9	24.0
11	8.0	7.0	2.0	0.0		17.0
12	10.0	12.0	2.0	0.0		24.0
13	7.0	6.0	2.0	0.0		15.0
14	6.0	8.0	1.0	0.0		15.0
15	0.0	7.0	0.0	0.0		7.0
16	0.0	3.0	0.0	0.0		3.0
17	1.0	3.0	0.0	0.0		4.0
18	0.0	1.0	0.0	0.0		1.0
TOTALS	63.0	64.0	14.0	0.0		141.0

SUMMARY STAND STATISTICS: INITIAL CONDITIONS FOR STAND AT AGE 80.

SPECIES :	1	2	3	4	5	TOTALS
N TREES:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	9.0	3.0	3.0	0.0		15.0
SAW	54.0	61.0	11.0	0.0		126.0
TOTAL	63.0	64.0	14.0	0.0		141.0
BA:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	3.0	0.9	1.0	0.0		4.9
SAW	38.8	55.0	8.0	0.0		101.8
TOTAL	41.8	55.9	9.0	0.0		106.8
PS:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	2.9	0.9	1.0	0.0		4.8
SAW	32.7	44.7	6.7	0.0		84.2
TOTAL	35.6	45.6	7.7	0.0		88.9
AVG DBH:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	7.8	7.5	7.8	0.0		7.8
SAW	11.3	12.7	11.4	0.0		12.0
CVOB 4.0:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	90.2	25.0	28.7	0.0		143.9
SAW	1492.4	2171.2	296.0	0.0		3959.5
TOTAL	1582.5	2196.2	324.6	0.0		4103.4
CVIB 4.0:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	77.7	21.2	26.3	0.0		125.2
SAW	1280.8	1816.8	270.0	0.0		3367.6
TOTAL	1358.5	1838.0	296.3	0.0		3492.8
CVOB 0.0:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	102.1	29.6	32.3	0.0		164.0
SAW	1542.7	2226.2	305.1	0.0		4074.0
TOTAL	1644.8	2255.8	337.5	0.0		4238.0
CVIB 0.0:						
SAP	0.0	0.0	0.0	0.0		0.0
POLE	87.5	24.8	29.5	0.0		141.7
SAW	1321.4	1857.8	278.0	0.0		3457.3
TOTAL	1409.0	1882.6	307.5	0.0		3599.0
BFVOL 8.0:						
SAW	3874.7	7063.6	851.7	0.0		11790.0
BFVOL 5.0:						
SAW	6189.1	9091.5	1310.1	0.0		16590.7

SUMMARY STATISTICS FOR ENTIRE GROWTH PROJECTION:

11

ATTRIBUTE	STAND AGE										TOTALS	
	30	35	40	45	50	55	60	65	70	75	80	TOTALS
N TREES:												
INITIAL	602.0	201.0	197.0	192.0	187.0	178.0	170.0	161.0	153.0	146.0	141.0	---
CUT	359.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	359.0
RESIDUAL	203.0	201.0	197.0	192.0	187.0	178.0	170.0	161.0	153.0	146.0	141.0	---
MORTALITY	2.0	4.0	5.0	5.0	9.0	8.0	9.0	8.0	7.0	5.0	5.0	62.0
BA:												
INITIAL	87.9	50.2	61.3	70.8	78.8	85.4	91.1	95.5	100.0	103.6	106.8	---
CUT	50.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.6
RESIDUAL	37.3	50.2	61.3	70.8	78.8	85.4	91.1	95.5	100.0	103.6	106.8	---
MORTALITY	0.5	0.4	0.7	1.1	2.7	2.2	3.3	2.7	3.2	2.1	2.1	18.8
NET GROWTH	12.8	11.2	9.5	7.9	6.7	5.6	4.8	4.1	3.6	3.2	3.2	69.5
GROSS GROWTH	13.3	11.5	10.1	9.1	5.3	7.9	8.1	6.8	6.8	5.2	5.2	88.3
PS:												
INITIAL	98.4	50.5	59.1	66.2	71.9	76.3	80.0	82.8	85.1	87.1	88.9	---
CUT	58.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.4
RESIDUAL	40.0	50.5	59.1	66.2	71.9	76.3	80.0	82.8	85.1	87.1	88.9	---
MORTALITY	0.5	0.4	0.8	1.2	2.5	2.2	3.1	2.6	2.9	1.9	1.9	18.1
NET GROWTH	10.5	8.7	7.0	5.7	4.5	3.6	2.8	2.4	2.0	1.8	1.8	48.9
GROSS GROWTH	11.0	9.1	7.8	6.9	7.0	5.8	5.5	5.0	4.5	3.7	3.7	67.0
QUADRATIC DBH:												
INITIAL	5.2	6.8	7.6	8.2	8.8	9.4	9.9	10.4	10.9	11.4	11.8	---
CUT	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---
RESIDUAL	5.8	6.8	7.6	8.2	8.8	9.4	9.9	10.4	10.9	11.4	11.8	---
MORTALITY	6.8	4.0	4.5	6.5	7.4	7.2	8.2	7.5	5.1	8.7	8.7	---
CV08 4.0:												
INITIAL	1169.9	1033.0	1460.4	1902.6	2274.5	2711.1	2973.0	3358.8	3589.5	3823.7	4103.4	---
CUT	580.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	580.5
RESIDUAL	589.4	1033.0	1460.4	1902.6	2274.5	2711.1	2973.0	3358.8	3589.5	3823.7	4103.4	---
MORTALITY	10.7	1.4	6.0	22.6	68.0	56.5	52.3	82.2	100.6	67.8	67.8	508.0
NET GROWTH	443.6	427.4	442.1	372.0	436.6	261.8	385.8	230.8	234.2	279.7	234.2	3514.0
GROSS GROWTH	454.3	428.8	448.1	394.6	504.6	318.3	478.1	312.9	334.8	347.5	347.5	4022.0
CV18 4.0:												
INITIAL	1010.2	887.2	1251.5	1627.0	1943.1	2312.9	2536.2	2861.5	3059.0	3257.3	3492.6	---
CUT	502.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	502.0
RESIDUAL	508.2	887.2	1251.5	1627.0	1943.1	2312.9	2536.2	2861.5	3059.0	3257.3	3492.6	---
MORTALITY	9.0	1.2	5.1	19.2	57.3	47.8	78.4	69.5	84.9	57.6	57.6	430.1
NET GROWTH	379.0	364.3	375.5	316.2	369.8	223.3	325.2	197.5	198.3	235.6	235.6	2984.7
GROSS GROWTH	388.0	365.5	380.6	335.4	427.0	271.1	403.6	267.1	283.2	293.1	293.1	3414.8
CV08 0.0:												
INITIAL	1986.0	1292.9	1713.5	2138.4	2456.7	2912.7	3158.0	3526.9	3743.2	3965.7	4238.0	---
CUT	1115.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1115.7
RESIDUAL	870.3	1292.9	1713.5	2138.4	2456.7	2912.7	3158.0	3526.9	3743.2	3965.7	4238.0	---
MORTALITY	12.4	6.9	15.1	30.8	82.1	68.7	104.2	93.2	109.3	74.2	74.2	596.9
NET GROWTH	422.6	420.6	424.8	358.3	416.0	245.3	368.9	216.3	222.5	272.3	272.3	3367.7
GROSS GROWTH	435.0	427.6	439.5	389.1	458.1	314.0	473.1	309.5	331.8	346.5	346.5	3964.6

CVIB 0.0:

INITIAL	1694.2	1099.5	1457.2	1817.2	2121.6	2473.3	2683.4	2994.7	3180.4	3369.4	3599.0	----
CUT	953.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	953.4
RESIDUAL	740.8	1099.9	1457.2	1817.2	2121.6	2473.3	2683.4	2994.7	3180.4	3369.4	3599.0	----
MORTALITY	10.4	5.8	12.8	25.8	68.9	57.7	87.9	78.4	91.7	62.6	29.8	502.1
NET GROWTH	359.1	357.3	360.0	304.4	352.2	209.6	311.3	185.7	189.0	229.6	280.7	2858.2
GROSS GROWTH	369.5	363.2	372.8	330.2	421.1	267.3	399.2	264.1	280.7	292.2	280.7	3360.3

BFVCL 8.0:

INITIAL	0.0	0.0	452.5	1296.4	2454.8	4025.4	5245.6	7227.0	8680.7	10206.1	11790.0	----
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESIDUAL	0.0	0.0	452.5	1296.4	2454.8	4025.4	5245.6	7227.0	8680.7	10206.1	11790.0	----
MORTALITY	0.0	0.0	0.0	0.0	138.8	0.0	0.0	0.0	59.5	61.0	0.0	259.7
NET GROWTH	0.0	452.5	843.8	1158.4	1570.6	1220.2	1981.4	1453.6	1525.5	1583.9	1583.9	11790.0
GROSS GROWTH	0.0	452.5	843.8	1158.4	1705.4	1220.2	1981.4	1453.6	1585.4	1644.8	1644.8	12049.7

BFVCL 5.0:

INITIAL	501.2	1140.5	2525.0	4340.6	5952.0	9083.2	9577.5	12100.5	13697.6	15081.7	16590.7	----
CUT	291.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	291.8
RESIDUAL	209.4	1140.5	2525.0	4340.6	5952.0	9083.2	9577.5	12100.5	13697.6	15081.7	16590.7	----
MORTALITY	32.7	0.0	0.0	0.0	198.3	93.6	115.8	217.9	267.4	148.9	148.9	1074.6
NET GROWTH	931.0	1384.5	1815.6	1611.4	2131.2	1454.3	2523.0	1597.0	1384.1	1509.0	1509.0	16381.3
GROSS GROWTH	963.7	1384.5	1815.6	1611.4	2329.5	1587.9	2638.8	1814.9	1651.6	1657.9	1657.9	17455.9

TABLE 6

STAND NUMBER 1 SITE INDEX 70.

SUMMARY STATISTICS FOR ENTIRE GROWTH PROJECTION:

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ATTRIBUTE	STAND AGE												TOTALS
	30	35	40	45	50	55	60	65	70	75	80		
N TREES:													
INITIAL	602.0	494.0	432.0	383.0	340.0	303.0	281.0	260.0	238.0	218.0	200.0	---	---
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	0.0
RESIDUAL	602.0	494.0	432.0	383.0	340.0	303.0	281.0	260.0	238.0	218.0	200.0	---	---
MORTALITY	108.0	62.0	49.0	43.0	37.0	22.0	21.0	22.0	20.0	18.0	18.0	---	402.0
BA:													
INITIAL	87.9	94.0	98.6	102.4	105.5	108.1	110.5	112.6	114.4	116.2	117.7	---	---
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	0.0
RESIDUAL	87.9	94.0	98.6	102.4	105.5	108.1	110.5	112.6	114.4	116.2	117.7	---	---
MORTALITY	8.6	7.2	7.5	7.1	6.8	5.9	6.4	5.6	6.2	5.9	5.9	---	67.6
NET GROWTH	6.0	4.7	3.7	3.1	2.7	2.3	2.1	1.9	1.7	1.6	1.6	---	29.8
GROSS GROWTH	14.6	11.8	11.6	10.2	9.4	8.3	8.5	7.5	8.0	7.5	7.5	---	97.4
PS:													
INITIAL	98.4	99.5	100.7	101.4	101.6	101.6	102.1	102.2	102.2	102.0	101.8	---	---
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	0.0
RESIDUAL	98.4	99.5	100.7	101.4	101.6	101.6	102.1	102.2	102.2	102.0	101.8	---	---
MORTALITY	11.3	8.5	8.7	7.8	7.3	5.5	6.2	5.6	6.1	5.7	5.7	---	73.1
NET GROWTH	1.2	1.2	0.6	0.2	0.0	0.4	0.2	-0.0	-0.2	-0.2	-0.2	---	3.5
GROSS GROWTH	12.5	9.7	9.4	8.1	7.3	6.3	6.4	5.6	5.9	5.5	5.5	---	76.6

QUADRATIC DBH:

INITIAL	5.2	5.4	6.5	7.0	7.5	8.1	8.5	8.9	9.4	9.9	10.4	-----
CUT	0.0	0.0	0.0	C.C	C.C	0.0	0.0	0.0	0.0	0.0	-----	-----
RESIDUAL	5.2	5.9	6.5	7.0	7.5	8.1	8.5	8.9	9.4	9.9	-----	-----
MORTALITY	3.8	4.6	5.4	5.5	5.8	7.0	7.5	6.8	7.6	7.8	-----	-----
CVOB 4.0:												
INITIAL	1169.9	1627.6	2021.9	2368.8	2795.4	3013.5	3383.6	3506.4	3842.1	4037.2	4290.1	-----
CUT	0.0	0.0	0.0	C.C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESIDUAL	1169.9	1627.6	2021.9	2368.8	2795.4	3013.5	3383.6	3506.4	3842.1	4037.2	-----	-----
MORTALITY	33.7	71.0	116.5	124.5	130.3	146.2	175.6	140.8	185.2	173.9	1297.3	1297.3
NET GROWTH	457.7	394.3	346.9	426.6	216.1	370.1	122.8	335.8	195.1	252.8	3120.2	3120.2
GROSS GROWTH	491.4	465.3	463.4	551.1	348.4	516.3	298.4	476.6	360.3	426.8	4418.1	4418.1
CVIB 4.0:												
INITIAL	1010.2	1402.1	1738.9	2033.5	2355.3	2581.5	2855.1	2999.8	3282.5	3448.4	3662.9	-----
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESIDUAL	1010.2	1402.1	1738.9	2033.5	2355.3	2581.5	2855.1	2999.8	3282.5	3448.4	-----	-----
MORTALITY	29.2	61.3	100.6	107.4	111.5	125.0	150.4	120.1	156.6	148.3	1112.4	1112.4
NET GROWTH	391.5	336.8	294.6	361.8	186.1	313.6	104.7	283.1	165.5	214.6	2652.7	2652.7
GROSS GROWTH	421.1	398.1	355.2	465.2	257.6	438.7	255.0	403.2	324.1	362.5	3765.1	3765.1
CVOB 0.0:												
INITIAL	1986.0	2324.7	2640.0	2909.6	3264.1	3413.1	3742.2	3828.6	4124.5	4284.9	4507.2	-----
CUT	0.0	0.0	0.0	C.C	C.C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESIDUAL	1986.0	2324.7	2640.0	2909.6	3264.1	3413.1	3742.2	3828.6	4124.5	4284.9	-----	-----
MORTALITY	176.7	164.0	194.3	194.0	191.4	179.5	205.0	175.9	213.1	199.6	1893.6	1893.6
NET GROWTH	338.7	315.3	269.6	354.5	149.0	329.2	86.3	296.3	160.0	222.3	2521.1	2521.1
GROSS GROWTH	515.4	479.3	463.9	548.5	340.5	508.7	251.3	472.2	373.2	421.9	4414.8	4414.8
CVIB 0.0:												
INITIAL	1694.2	1981.7	2249.5	2477.9	2778.1	2906.4	3185.4	3260.0	3510.3	3647.1	3836.5	-----
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESIDUAL	1694.2	1981.7	2249.5	2477.9	2778.1	2906.4	3185.4	3260.0	3510.3	3647.1	-----	-----
MORTALITY	150.9	139.7	165.1	165.3	161.8	152.4	174.2	148.8	181.1	169.0	1608.3	1608.3
NET GROWTH	287.5	267.8	228.4	300.2	128.3	279.0	74.5	250.3	136.8	189.4	2142.3	2142.3
GROSS GROWTH	438.4	407.4	393.5	465.5	250.1	431.4	248.7	399.1	317.9	358.5	3750.7	3750.7
BFVCL 8.0:												
INITIAL	0.0	0.0	151.0	535.7	1243.5	1884.5	3388.4	4263.9	5946.8	7553.2	9109.6	-----
CUT	0.0	0.0	0.0	0.0	C.C	0.0	C.C	0.0	0.0	0.0	0.0	0.0
RESIDUAL	0.0	0.0	151.0	535.7	1343.5	1884.5	3388.4	4263.9	5946.8	7553.2	-----	-----
MORTALITY	0.0	0.0	C.C	0.0	0.0	0.0	0.0	58.7	0.0	61.0	119.7	119.7
NET GROWTH	0.0	151.0	384.7	807.8	541.0	1503.9	875.5	1682.9	1606.4	1556.4	9109.6	9109.6
GROSS GROWTH	0.0	151.0	384.7	807.8	541.0	1503.9	875.5	1741.6	1606.4	1617.4	9229.3	9229.3
BFVCL 5.0:												
INITIAL	501.2	1132.0	2303.3	3120.0	5523.7	6734.2	8725.5	9937.8	11997.8	13671.0	15463.9	-----
CUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RESIDUAL	501.2	1132.0	2303.3	3120.0	5523.7	6734.2	8725.5	9937.8	11997.8	13671.0	-----	-----
MORTALITY	0.0	0.0	0.0	0.0	62.5	224.2	263.6	190.7	259.1	293.3	1293.4	1293.4
NET GROWTH	630.8	1171.3	1416.6	1803.7	1210.6	1991.2	1212.4	2060.0	1673.2	1792.9	14962.7	14962.7
GROSS GROWTH	630.8	1171.3	1416.6	1803.7	1273.1	2215.4	1476.0	2250.6	1932.3	2086.2	16256.1	16256.1

Basal area, total cubic-foot volume inside bark and International 1/4-inch board-foot volume extracted from [11] and [12] are plotted in Figure 2. Gross growth for the 50-year projection was reduced in the heavily thinned stand—88.3 square feet of basal area growth, compared to 97.4 for the unthinned stand, and 3369 cubic feet compared to 3750, respectively. Net growth, however, showed a marked increase for the thinned stand. Net basal area growth for the thinned stand was 69.5 square feet; for the unthinned stand it was only 29.8. Net cubic volume growth was 2858 cubic feet, compared to 2142. Mortality was sharply reduced with thinning, particularly for the first 20 years after thinning.

The thinned stand had 16,590 board feet per acre at age 80—7 percent more than the unthinned stand. (Board foot yields for the unthinned stand also compare favorably with those from Schnur's yield tables.) Since the unthinned stand had 145 trees in the sawtimber size class compared to only 126 for the thinned stand, the gain in sawtimber volume was due to the increase in tree size—the arithmetic mean d.b.h. for sawtimber was 12.0 inches in the thinned stand and only 11.1 inches in the unthinned stand. Larger trees also have more value.

Even though gross growth rates were reduced somewhat by thinning this stand to 40 percent stocking, gains in net growth and board-foot yields indicate that a heavy thinning at age 30 is still a viable option. This run of OAKSIM also suggests another alternative: to thin initially to 40 percent and again at age 50 to perhaps 60 percent, since mortality started to increase at that age. However, a considerable number of other options regarding the frequency, timing, and intensity of thinning need to be explored to arrive at optimum management guidelines for this stand.

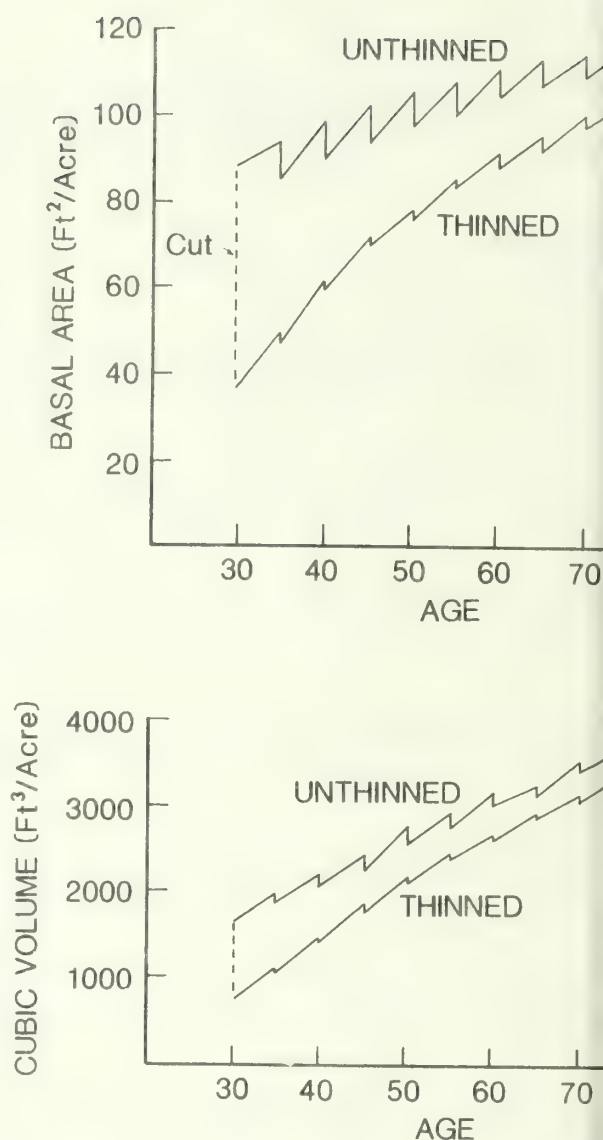


Figure 2.—Basal area, cubic-foot volume (total inside bark), and International 1/4-inch board-foot volume (all trees 8.6 inches d.b.h. and larger to inch top) per acre for sample run of OAKSIM.

Discussion

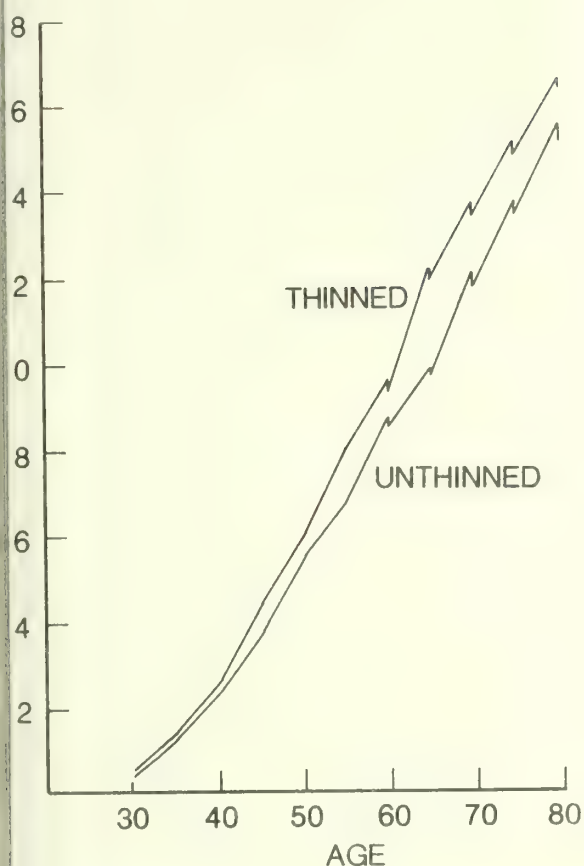
OAKSIM is available from the author upon request. The program consists of approximately 1500 cards, and should be compiled to save computing costs. Control cards and data can be stored in a separate data file and read during execution. Use of a CRT screen and a text editor language package maximizes the program's flexibility. The ages and intensities of thinning can then be changed easily to test a variety of management alternatives. Execution time on the AMDAHL/IBM 470 V/6 computer is approximately 10 seconds for a 50-year projection for one stand.

This initial version of OAKSIM is applicable to a wide range of age, site, and stocking conditions for a large portion of the upland oak timber type. The ultimate goal is to produce a complete simulator capable of generating the entire growth cycle—not just the growth of the present stand, but also ingrowth and regeneration. Ingrowth can be substantial in heavily thinned upland oak stands. And once these ingrowth trees are cut during the rotation harvest, the resulting stump sprouts will most likely determine the species composition of the next stand. Timber management planning for the current rotation, however, should be based primarily on those trees already covered by this version of OAKSIM, not on ingrowth trees.

Future enhancements planned for OAKSIM should also encourage application of the simulator. Computer programming statements will be added to allow input from variable-plot (prism) timber cruises. This will eliminate the need for users to construct their own stand tables for input into OAKSIM. A microcomputer version of OAKSIM will also give more users access to the simulator.

Acknowledgment

The author thanks Greg Robison, computer specialist, for his many long hours of dedicated assistance in the development of the OAKSIM computer program.



Literature Cited

- Carmean, W.H. **Site index curves for black, white, scarlet, and chestnut oaks in the central states.** Res. Pap. NC-62. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1971. 8 p.
- Carmean, W. H.; Hahn, J. T. **Site comparisons for upland oaks and yellow-poplar in the central states.** Journal of Forestry 81:736-739; 1983.
- Hilt, D.E. **OAKSIM: An individual-tree growth and yield simulator for managed, even-aged, upland oak stands.** Res. Pap. NE-562. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 21 p.
- Hilt, D.E.; Rast, E.D.; Bailey, H.J. **Predicting diameters inside bark for 10 important hardwood species.** Res. Pap. NE-531. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 7 p.
- Little, Elbert L. **Important forest trees of the United States.** Agric. Handb. 519. Washington, D.C.: U.S. Department of Agriculture; 1978. 70 p.
- McQuilkin, R. A. **Site index prediction table for black, scarlet and white oaks in southeastern Missouri.** Res. Pap. NC-108. St. Paul, MN: U. S. Department of Agriculture, North Central Forest Experiment Station; 1974. 8 p.
- McQuilkin, R. A. **Site index comparisons between black oak and five other upland oaks and shortleaf pine in Missouri.** Res. Pap. NC-266. St. Paul, MN: U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1985.
- Schnur, L.G. **Yield, stand, and volume tables for even-aged upland oak forests.** Tech. Bull. 560; Washington, DC: U.S. Department of Agriculture; 1937. 87 p.

Hilt, Donald E. **User's guide to OAKSIM: An individual-tree growth and yield simulator for managed, even-aged, upland oak stands.** Gen. Tech. Rep. NE-104. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 22 p.

This user's guide presents operating instructions for OAKSIM, an individual-tree growth and yield simulator for managed, even-aged, upland oak stands. Growth and yield projections can be made with OAKSIM for various thinning alternatives for up to 50 years. The general structure and operation of OAKSIM, program control information, data formats, and program output are presented, with examples of thinned and unthinned projections.

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Keywords: Increment; thinning

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Black Locust in the Reclamation Equation

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Abstract

Black locust (*Robinia pseudoacacia*) has been planted and seeded more than any other tree species on lands surface-mined for coal in the Eastern United States. Benefits from planting black locust are: it provides quick cover for stabilization and esthetics; it supplies nitrogen and nutrient-rich litter to soil; it improves the site for establishment of other higher quality trees; it grows in a wide range of minesoil conditions, including extremely acid soils; it grows better than most trees in soils compacted by grading and topsoiling practices; it can be established by seeding and it is useful for posts, fuel, and biomass production. Problems associated with planting black locust are: it may overtop and damage companion trees; it may be susceptible to locust borer damage; it spreads to adjacent open areas by root suckers and seed; its thorns are hazardous to people and equipment; and seeded stands may be nearly impenetrable to about 6 to 8 years of age. Black locust continues to have an important place in mined-land reclamation; planning for its best use is warranted.

roduction

A major goal in reclaiming disturbed lands is to develop a permanent plant cover. Trees have been used widely and successfully for this purpose. Black locust (*Robinia pseudoacacia*) has been one of the best species, though it has some limitations for some uses.

Early uses of black locust were along roadsides and in gullied fields to stop erosion and enrich soil nitrogen. As surface mining for coal developed, this native legume was used in reclaiming mined lands, where often it grew faster than on unmined lands (Limstrom 1960). It is one of the most adaptable trees used in reclamation and has been planted more than any other tree species on mined-land spoils in the United States. Black locust has been planted in pure stands and in mixtures with other trees on many types of soils throughout the Appalachian and Interior (Midwest) Coal Provinces.

A key feature of black locust is that it is a pioneer species, and surface mines are pioneer sites. Important contributions of this species in reclaiming surface mines include: enhances soil development by supplying nitrogen and nutrient-rich litter and improving soil aeration; provides quick cover for erosion control and improved water infiltration; fosters successional development of high-quality forest stands; furnishes food and cover for wildlife; contributes to landscape

design and esthetics; screens unsightly views; and limits access, at least temporarily, to hazardous and environmentally sensitive sites.

When black locust was first used on surface mines, methods of mining and reclamation were much different from today's regulated practices. Little or no attempt was made to segregate different geologic materials lying above the coal. The resulting mixture that was piled in ridges and hills became the rooting medium. Often, this medium was not good for plant growth; however, black locust was able to survive and grow on many of these sites where most other tree species failed.

Public concerns about mined areas that were not being suitably reclaimed led first to passage of state laws, and later to the Federal Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87). Numerous regulations aimed at achieving certain land uses resulted from this law and brought about changes in handling of soil and plant materials during reclamation. Planting of black locust has continued, but these regulations have introduced new obstacles to successful establishment of woody species. The record of tree growth under these new conditions is necessarily short, but locust promises to be especially useful in adapting to postmining conditions.

Ways to Plant Black Locust

The versatility of black locust is seen in the ways it can be planted and used. Some plantings are for direct use as fenceposts, biomass, and barriers, and for erosion control, landscaping, and environmental quality. Black locust also enhances soil building and site quality. It can serve as a nurse crop for more valuable hardwoods planted either with the locust or after the locust stands have improved the site and begun dying off, or which volunteer during natural ecological succession. Many of the locust stands planted on mined lands have deteriorated at age 15 to 30. Black locust is intolerant of shade and does not regenerate well under its own or other tree canopies. Stands can be managed, usually by cutting that results in regeneration from sprouts. Individual trees have persisted without management in some stands.

Locust commonly spreads by root suckers into adjacent open areas. Spreading can be advantageous in revegetating refuse sites, controlling erosion, and covering bare areas. Where not desired, chemical or mechanical control can be used.

Planting Seedlings

The spacing and number of black locust seedlings planted per unit area may vary depending on the

intended use. Where planted alone, spacings have ranged from 7 by 7 feet or about 890 stems per acre, to 4 by 4 feet or about 2,725 stems per acre. Closer spacings are used mostly on steep slopes and potentially unstable sites and for barriers or screens. Densities of older stands may be greater than desirable even with the 7- by 7-foot spacing. Where used as a nurse or companion crop for other hardwoods, black locust may account for 25 to 50 percent of the total trees planted. Planting a locust in every other planting space in every other row provides a 25-percent composition. A simpler approach is to plant every third row to locust.

State-operated forest nurseries are the chief source of black locust seedlings for large-scale plantings. Lesser numbers are available from some commercial nurseries. One-year-old (1-0) seedlings are planted almost exclusively in the Interior Coal Province (Indiana to Kansas) and as an alternative to direct seeding in the Appalachian Coal Province (Pennsylvania to Alabama).

Five hundred or more seedlings can be hand planted per day by one person, and several times that many with a tree-planting machine. Planting bars or mattocks are used for hand planting. An added advantage with machines is that they can be equipped with a spray apparatus for simultaneous herbicide application to control herbaceous competition and for fertilizer applications to correct soil nutrient deficiencies.

Direct Seeding

Black locust is one of the easiest tree species to establish by direct seeding; seed are commercially available at moderate prices. The small, hard seeds are prevented naturally from premature germination on harsh sites. Seed can be scarified with sulfuric acid before planting to increase the percentage of early germination. This increases the need to protect seed and newly emerged seedlings from climatic stress. Use of moderate amounts of

bark or other mulch with treated seed has provided conditions for increased survival of seedlings on field plots (Roberts and Carpenter 1983). Other causes of seed or seedling loss are erosion and animal use.

Black locust seed can be broadcast by hand or mechanical seeders or drilled. Most seeding, especially in the Appalachian Coal Province, is done with hydraulic seeders that spread mixtures of grass, herbaceous legume, and locust seed as well as mulch and fertilizers in one application. Locust usually is seeded at rates of 1 to 3 pounds of pure live seed per acre (Vogel 1981). Newly germinated locust seedlings may be difficult to find in dense covers such as those of sericea lespedeza (*Lespedeza cuneata*) or Kentucky-31 tall fescue (*Festuca arundinacea*), but after 2 to 3 years, a dense stand of black locust saplings is visible. Usually, canopy closure and a decrease in stand density soon follow.

Use of Amendments and Herbicides

Both planted and seeded black locust, unlike many tree species, respond positively to fertilizers applied at planting. Growth of locust is increased on most mine-

soils by phosphorus fertilizer; nitrogen applied with phosphorus usually results in additional early-growth response. In an experiment on extremely acid spoil in eastern Kentucky, dicalcium phosphate, rock phosphate, or treble superphosphate similarly increased growth response by planted locust seedlings. The phosphate fertilizer was mixed with soil in the planting holes and nitrogen fertilizer was applied in slits about 8 inches from the seedlings. This was done to prevent direct contact of the nitrogen fertilizer with seedling roots. Survival after 3 years was not affected by any of the fertilizer treatments (Plass 1972).

In a similar experiment, application of (1) lime alone, (2) lime and fertilizer, and (3) lime, fertilizer, and straw mulch increased the survival and growth of black locust seedlings planted on extremely acid spoil in eastern Kentucky and Ohio. A significant growth response resulted from each additional amendment (Table 1). The fertilizers dicalcium phosphate and ammonium nitrate, were applied in and adjacent to the planting holes as in the experiment cited previously. Ground limestone was mixed into the upper 4 inches of spoil. These treatments would be

Table 1.—Survival and growth response of planted black locust to lime, fertilizer, and mulch on acid surface-mine spoils in eastern Kentucky and Ohio after 3 years

Treatment	Survival		Height	
	Kentucky	Ohio	Kentucky	Ohio
	-- Percent --		-- Feet --	
Control ^a	60	60	2.4	3.6
Lime ^b	100	75	5.3	5.2
Lime and fertilizer ^c	100	90	11.3	6.9
Lime + fertilizer + mulch ^d	95	95	13.6	8.7

^a Average pH of unlimed spoil: Kentucky 3.8; Ohio 3.3.

^b Finely ground agricultural lime applied at rate of 15 tons/acre and worked 4 inches deep into spoil.

^c Ammonium nitrate and dicalcium phosphate fertilizers applied at rates equivalent to 50 lb of nitrogen and 100 lb of P₂O₅ per acre.

^d Straw mulch 2 to 3 inches deep held in place with poultry wire.

Survival and Early Growth

too costly and unnecessary in reclamation prescribed by present regulations. However, they may be useful in revegetating acid-toxic spoils such as those found on some abandoned mined areas.

Establishment and growth of seeded black locust can be enhanced with amendments. The broadcast application of treble superphosphate on eastern Kentucky spoils seeded to black locust produced seedlings the first year that were 3 to 5 times taller than seedlings on unfertilized spoils. Nitrogen fertilizer applied with phosphorus resulted in additional growth, but the nitrogen was not necessary for success of the locust (Vogel and Berg 1973). Locust roots have nodules in which *rhizobium* bacteria fix appreciable amounts of nitrogen.

Under current regulations, trees are planted in or with a grass and legume ground cover that is established for erosion control. The application of fertilizer increases growth of the ground cover which, in turn, increases competition with the trees. Black locust usually is more successful than other trees in becoming established in such ground cover (Vogel 1977).

Use of herbicides to control herbaceous competition has improved tree survival and growth. Herbicides must be used as specified, and their effectiveness varies depending on soil leachability, seasonal weather conditions, and types of plants to be controlled. Damage to black locust trees from improper use of a wide spectrum of herbicides has ranged from none to significant depending on the chemical and the dosage (White and Wolfe 1983). Bentazon and 2,4-DB reduced the growth of locust seedlings.

Black locust seedlings ranked well compared to other kinds of trees in USDA Forest Service studies of survival and early growth on prelaw ungraded spoils. The number of surviving black locust trees in Illinois after 10 years exceeded 70 percent of those planted except on densely vegetated areas or very acid spots, where survival was less than 20 percent for any tree species tested (Boyce and Neebe 1959). After 10 years, black locust survived and grew better than other trees tested in Ohio (Finn 1958) and western Kentucky (Boyce and Merz 1959), and was rated good in independent studies in Pennsylvania (Hart and Byrnes 1960).

Spoils at most of the planting sites in Illinois and Indiana were

neutral to moderately alkaline. Survival of black locust on these spoils tended to increase with an increase in pH, a relationship not found for the more acidic minesoils of the Missouri, Kansas, and Oklahoma plantings (Table 2). Survival of black locust after 11 years on acid bituminous spoil in Pennsylvania was 50 percent or better only on spoil with pH levels above 3.6; tree height on the three best sites averaged only 10.1 feet (Davidson 1979). In general, growth in Illinois, Indiana, Missouri, Kansas, and Oklahoma was relatively independent of pH (Table 2). Adherence to current reclamation requirements should result in a minesoil pH range suitable for good survival and growth of black locust.

Table 2.—Spoil pH and black locust survival and growth on plots in Illinois and Indiana, and in Missouri, Kansas, and Oklahoma^a

Illinois/Indiana				Missouri/Kansas/Oklahoma				
pH					pH			
1947	1976	Survival	D.b.h.		1948	1976	Survival	D.b.h. Height
		Percent	Inches				Percent	Inches Feet
3.4	4.7	16	7.7		3.7	5.7	50	5.3 44
4.3	4.8	21	4.5		4.5	6.5	34	5.6 40
6.1	6.1	16	6.5		5.1	5.5	42	5.8 39
6.9	7.0	38	5.0		5.2	5.9	19	5.1 39
7.2	7.7	38	7.5		5.9	7.5	34	5.1 37
7.5	8.2	35	7.2		6.0	5.8	40	6.9 42
7.6	7.2	30	8.2		6.3	7.3	11	7.3 48
7.6	7.7	34	6.5		6.5	6.3	54	6.7 41
8.0	7.8	30	6.1		6.8	6.7	41	7.1 46
8.1	8.1	64	6.8		6.8	6.5	22	6.6 34
8.2	6.0	42	4.1		7.5	7.4	43	6.3 46
8.3	7.6	66	7.0					

^a Survival and growth measured in 1976; trees planted in 1947.

Locust Mortality and Tree Invasion

The canopy formed by rapid early growth of black locust often does not persist. There may be a large loss of trees and breakup of the stand. Mortality, breakage, and growth loss in black locust stands often occur by age 15. These symptoms of decline are caused primarily by the locust borer (*Megacyllene robiniae*) and to a lesser degree by the twig borer (*Ecdytolopha insiticiiana*), the leaf miner (*Adontota dorsalis*), and rimous heart rot (*Fomes rimosus*) (Hoffard and Anderson 1982). Large monoculture stands are more susceptible than dispersed individual trees to attack from exploding populations of insects.

Borer attacks are least severe, or absent, on vigorously growing trees (Hall 1933). Shade, highly correlated with lessened attacks, may be an effect of unbroken crown canopy which develops quickly from vigorous trees. Drought, acidic spoil, fire, or other damage that weakens trees and retards canopy closure may lead to increased borer damage. In southeastern Kentucky, borer damage may be found on black locust growing on sites disturbed by surface mining and road building, though such damage usually is not found on locust that regenerates naturally after logging of forest sites.

It may be that susceptibility to borer damage is greater for black locust outside the original range for this species. A more favorable forest environment and the presence of better adapted genetic strains in the natural range may lessen the prevalence of borer attack. Much of the commercially available black locust seed used for nursery plantings and in direct seeding originates in Europe from genotypes of unknown origin taken there many years ago.

Several studies have documented the general opinion and numerous observations that mortality is widespread in locust stands on disturbed lands. For example, a locust stand in southern Illinois planted in 1938, 3 years after

mining, had 2,700 trees per acre after 1 year, 1,170 per acre after 10 years, and 400 per acre after 15 years (Ashby et al. 1966). As locust trees died they were replaced by boxelder (*Acer negundo*), elm (*Ulmus* spp.), and other mesic hardwoods. Woodland herbs, predominantly white snakeroot (*Eupatorium rugosum*), had formed a continuous ground layer. Natural mortality in black locust stands in eastern Kentucky was similar at 10 years to that in the stand in southern Illinois (Eigel et al. 1980).

Detailed studies of a hydro-seeded stand in Bell County, southeastern Kentucky, showed 290 black locust trees per acre 12 years after seeding, with a third of the trees dead. Most of the 195 live trees per acre were less than 4 inches in diameter and would not have been commercially valuable for posts. The locust had grown through an initially thick stand of sericea lespedeza and Kentucky-31 tall fescue to form a dense thicket of seedlings at about age 6. At age 12, about one-third of the area had a ground layer predominantly of Ky-31 fescue, while the majority of the area had a dense, waist-high cover of white snakeroot, touch-me-not (*Impatiens capensis*), pokeberry (*Phytolacca americana*), and other woodland herbs. Borer damage was nil and little locust regeneration was observed. Only 32 stems of woody invaders per acre were counted, about half of them shrubs. Sugar maple (*Acer saccharum*), red maple (*A. rubrum*), and ash (*Fraxinus* spp.) accounted for most of the tree invasion. Lack of seed sources, or the vigor of the herbaceous layer, may have been the reason for the meager tree invasion. Some older stands in southeastern Kentucky have shown continued locust mortality with numerous invading trees of other species that later formed a continuous canopy. Locust is shaded out as the new trees grow taller.

The kind and number of trees that invade or volunteer in black locust stands differ from those invading in planted stands of other

tree species. They also differ from one minesoil type to another. In Ohio, for example, black cherry (*Prunus serotina*) volunteers were more abundant in plantations of black locust than in plantations of other species, and were more abundant on acidic and neutral spoils than on calcareous spoils (Larson 1984).

Regional differences have also been noted. In Illinois, 30-year-old locust stands were invaded preferentially by boxelder and elm, in Illinois and Indiana by sugarberry (*Celtis laevigata*) and hackberry (*Celtis occidentalis*), and in Missouri and Kansas by red mulberry (*Morus rubra*) (Ashby et al. 1980). In Indiana, Japanese honeysuckle (*Lonicera japonica*) has formed deep mats of vines between and on the remnants of pure locust plantings.

To summarize, as black locust die from whatever cause and stand densities decrease and give way to a more open overstory, the existing herbaceous ground layer is maintained, or one develops. Shade-tolerant, cool-season grasses, especially Ky-31 fescue, that often are seeded with the locust commonly form a dense ground cover that persists and even thrives with the locust (Fig. 1). This fescue-locust community frequently found on reclaimed surface mines in the Appalachian and Interior Coal Provinces appears to be unusually stable. Where not dominated by Ky-31 fescue, crown vetch (*Coronilla varia*), or other shade-tolerant species, the main ground-cover component under open locust stands typically is the woodland herb flora described earlier (Fig. 2). Sericea lespedeza where sown with grass and black locust typically dominates the ground cover for several years, but seemingly is reduced in density or shaded out when the locust canopy closes. Tree invasion that eventually replaces the locust takes place at varying rates depending on type of herbaceous understory and the proximity and kind of forest-seed source.



Figure 1.—The understory cover in this planted stand of black locust is Ky-31 tall fescue. Locust-fescue communities remain relatively stable for many years.



Figure 2.—The understory cover in this 12-year-old stand of seeded black locust is predominantly pioneer woodland forbs. The ground cover previously was a dense stand predominantly of *sericea lespedeza*.

Interplanting and Underplanting with Other Trees

Three methods of improving or creating hardwood stands in black locust plantings are (1) interplant desirable trees with locust, (2) underplant deteriorated locust stands, and (3) cut out or chemically kill the locust and replant with desired species. The first two have been of greatest importance on surface mines. Selection of shade-tolerant companion trees can enhance the probability of success.

A major reason for planting black locust with other more desirable or commercially important trees is the role of locust in improving soil and supplying fixed nitrogen to companion trees. Also, planting trees is a way to control stand composition of desirable species. Natural plant succession, too, brings new kinds and numbers of trees, but these often are of less value for forest products, for example the elm or mulberry listed previously.

Hardwood-black locust mixtures have been evaluated for survival and growth both of the locust and of the associated species. Sometimes direct comparisons of each species planted alone, and mixed, were possible. In other cases, the experimental design of 30 years ago only allows inferences from reasonably comparable plantings.

Black locust in mixed plantings generally had similar or better survival than in pure plantings (Table 3). Growth after 30 years was variable. Locust trees tended to be larger in plantings with the higher percentages of black locust in the mixture. The values were affected by different companion trees planted with locust in the several areas, by amount of locust borer damage, and by climatic stress and other environmental factors.

The primary interest and concern in interplanting is the influence of black locust on the growth of companion trees. Interplanting with black locust has in some cases

enhanced and in others limited the growth of companion trees. Several early reports on mixed plantings indicated overtopping and crowding of companion trees by locust and damage from wind whipping of tender shoots by thorny locust branches. Despite these early adverse effects, several companion species have grown well (Ashby and Kolar 1977).

Interplanting pines (*Pinus* spp.) with locust has not been very successful. Kellogg (1936) reported failure for numerous pine species interplanted with locust. Larson and Vimmerstedt (1983) found that only 13 percent of the white pine (*Pinus strobus*) that had been interplanted with black locust survived after 30 years. This compares with 21 percent survival where pine was not interplanted. Tree diameter also was greater for pine not interplanted.

One study in southeastern Ohio showed enhanced growth of trees planted in mixture with black locust on acid spoils. At age 10, tulip poplar (*Liriodendron tulipifera*), green ash (*Fraxinus pennsylvanica*), and redcedar (*Juniperus virginiana*) were 228, 268, and 194 percent taller, respectively, where interplanted with locust than where planted in pure stands. Total nitrogen content in leaves was 1 percent greater on trees planted with locust (R. F. Finn and R. W. Merz, unpublished report, Central States Forest Experiment Station). Though associated with better growth, higher nutrient content in plant tissue may produce undesirable side effects. For example, deer browsing was greater on pines growing near black locust than on those not near locust in Pennsylvania (Davidson 1970).

Table 3.—Thirty-year survival and growth of black locust in pure stands and mixed with other trees. Ohio data from Larson and Vimmerstedt (1983).

Area	Survival	D.b.h.	Height
	Percent	Inches	Feet
PURE LOCUST			
Ohio	18	5.3	28
Indiana	68	5.5	41
Missouri	39	6.5	42
Kansas	33	5.4	40
Oklahoma	11	7.2	48
MIXED			
Ohio	34	5.0	28
Indiana	64	6.9	55
Northern Illinois	34	5.7	—
Southern Illinois	22	7.2	—
Kansas	25	6.7	49

Grading Effects on Trees in Reclamation

Growth differences at age 30 were not great between trees planted alone and trees mixed with locust in several states (Table 4). Two of seven comparisons showed greater diameter with locust, while the other five showed better growth when planted alone. Older comparisons are not available to predict the future growth of these stands.

If suppression by black locust limits early growth of interplanted companion trees, underplanting deteriorated locust stands may avoid this problem and take advantage of improved soil conditions. Results of underplanting have ranged from failure to highly successful, with little explanation for the differences. Data on tree performance in underplanted black

locust stands compared with plantings in the open are not available. A comparison of underplanted locust versus underplanted shortleaf pine (*Pinus echinata*) of the same age generally showed better survival of trees planted under the pine but better growth under the black locust (Ashby and Kolar 1977). By age 37, 30 years after the underplanting, survival of both locust and pine was 6 percent.

We do not know of surface-mined areas planted after the complete removal or deadening of black locust. The residual effects of harvested locust have supported superior growth of hardwoods on poor, old-field soils (Carmean et al. 1976).

Significant changes in post-mining soil conditions have been noted following enactment of state and Federal reclamation laws. Where chemical factors once were perceived as the major limitations to plant growth, today, much concern and research is directed toward physical limitations, chiefly those associated with grading.

Graded landscapes are much more complex than often realized. The smooth surfaces may hide differences that become evident only after trees are planted. Studies on graded versus ungraded pre-law minesoils showed that grading interacted with site and spoil conditions to produce several types of tree-growth response. In an Ohio study, black locust grew better on the fill material on graded spoil banks than on the cut area from which the fill material was removed. Average tree height on partially graded banks was greater than on leveled banks and about the same as on ungraded banks. Tree growth was best on side slopes of the partially graded and ungraded banks (Fig. 3).

Locust on plots partially leveled by dragline pullback in southern Illinois had a diameter at breast height (d.b.h.) of 6.5 inches after 30 years compared to 7.7 inches on ungraded plots. Survival percentages were equal even though spoil pH was 6.1 and 3.4 for the graded and ungraded plots, respectively. The grading limited tree growth more than the extreme acidity.

Table 4.—Thirty-year growth of hardwoods and white pine planted alone or mixed with black locust on Indiana, Kansas, and Ohio strip mines. Ohio data from Larson and Vimmerstedt (1983).

Species	D.b.h.		Height	
	Alone	Mixed	Alone	Mixed
	-- Inches --		-- Feet --	
Sweet gum (<i>Liquidambar styraciflua</i>) (IN)	8.8	7.2	62	57
Red oak (<i>Quercus rubra</i>) (IN)	8.1	6.9	62	53
Silver maple (<i>Acer saccharinum</i>) (IN)	6.0	7.3	58	56
Black walnut (<i>Juglans nigra</i>) (IN)	5.0	4.1	47	36
Black walnut (KS)	3.0	3.6	23	31
Tulip tree (<i>Liriodendron tulipifera</i>) (OH)	6.2	6.0	38	35
White pine (<i>Pinus strobus</i>) (OH)	7.3	6.0	34	33

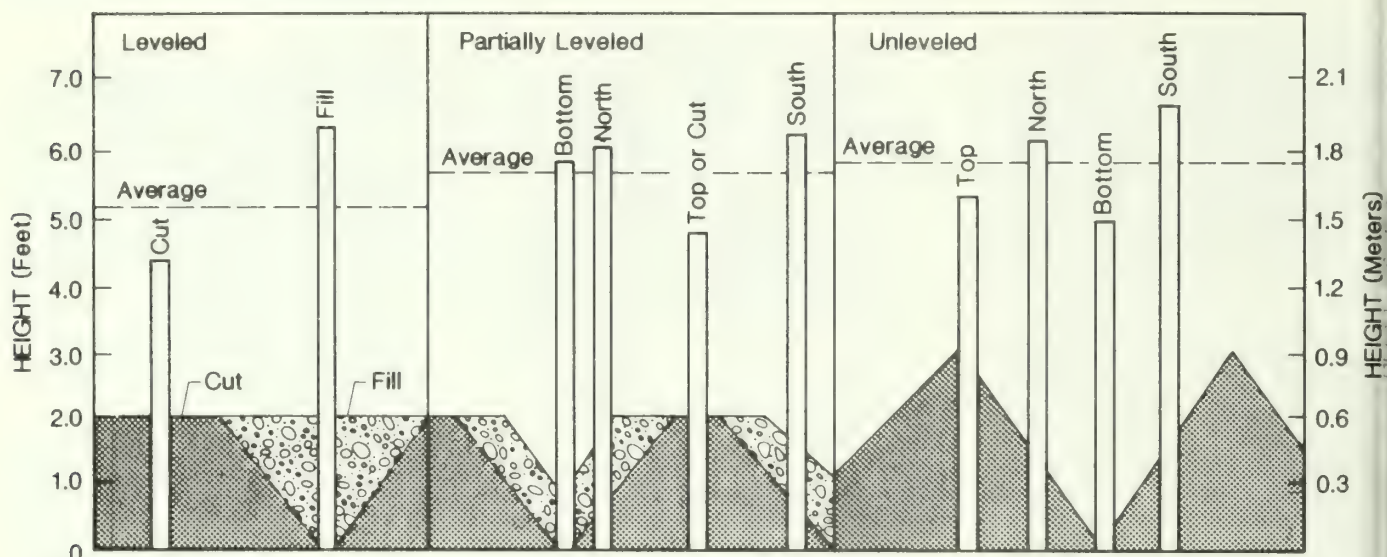


Figure 3.—Relative height of 2-year-old black locust planted on leveled, partially leveled, and unleveled spoil banks in Ohio (from Merz, R. B. unpublished Central States Forest Experiment Station Research Report, 1948).

There was little difference in locust survival, d.b.h., and height on unleveled, partially leveled, and completely leveled plots in Ohio though trees on the partially leveled area had a significantly smaller average d.b.h. than on the other two areas (Larson and Vimmerstedt 1983). Detrimental effects of grading on height growth of locust were found in West Virginia by Brown (1973). We found 2 to 11 percent greater diameter and height growth of locust after 30 years on ungraded areas than in similar plantings on graded minesoils in Missouri and Kansas. The effect of possible interactions of soil compaction with borer damage or other factors on locust were not identified in these studies.

Grading was beneficial to survival and growth of black locust on coarse-textured anthracite minesoils in Pennsylvania (Czapowskyj 1970). Locust survival after 5 years averaged 64 percent on graded and 22 percent on ungraded coarse spoil

materials. Rolling and sliding rocks and erosion caused considerable mortality on ungraded banks. Trees were 9.8 feet tall on the graded sites and only 4.6 feet on the ungraded. On an area with finer textured soils (sandy clay loam), the average height of trees on the graded site was 6.2 feet compared to 5.2 feet on the ungraded. Thus, grading appears to benefit growth of black locust on coarse-textured materials, but is detrimental to growth on finer textured minesoil materials, such as are commonly found in the Midwest.

Growth of black locust at age 10 was less affected by grading than three other tree species in Ohio (Finn 1958). At age 30, locust had the highest survival but not the best growth of 13 species planted on graded sites in Missouri, and the second best survival in Kansas. Our recent studies in Illinois showed that survival of black locust after 2 years was only 40 percent on graded sites compared to 100

percent on ungraded sites. Tree height averaged 4.9 feet on graded and 11.5 feet on ungraded sites. Development of root systems also was markedly reduced on the graded spoils. Even so, the locust had deeper roots and grew more vigorously than the other 12 kinds of trees planted on the graded sites.

Black locust recently has been planted on graded agricultural minesoils to test the hypothesis that locust root systems are more effective than alfalfa (*Medicago sativa*) or sweet clover (*Melilotus* spp.) in penetrating compacted soil layers. Locust may well be a good choice for improvement of minesoils in the early years after mining and before planting corn and other row crops. This would be a means to offset adverse effects caused by grading the replaced fine-textured surface-soil materials.

Consumptive and Other Uses

Black locust is a relatively dense wood with high value for firewood. It ranked 6th (behind oak) in density and heat value out of 33 woods reported by the USDA Forest Service (n.d.). The cutting and removal of firewood should limit the buildup of borer populations and encourage sprouting to renew the stand.

Black locust is one of the most promising species to plant on surface mines for production of wood for industrial heating and generation of electrical power, and as a chemical feedstock. Young stands typically are harvested for such biomass production. The wide adaptability of locust to a diversity of sites, its nitrogen-fixing capacity, and quick growth provide an early harvestable crop (Eigel et al. 1980). Locust sprouts are more vigorous than the original planting and have produced more than 2.25 tons per acre of biomass per year in western Kentucky (Carpenter and Eigel 1979). Locust had superior performance in a Kansas energy forest (Laughton 1980).

Letting the stand grow to a size for fenceposts or mine props is a traditional use of black locust (Loggers 1951). Fencepost production may well be deferred to a sprout generation to gain vigor, a denser canopy, and stands less subject to borer attacks (Finn and

Limstrom 1957). Where not exposed to borer attack before a sprout canopy is renewed, better trees could be left for posts during short-rotation harvesting for biomass or firewood.

Living fences or barriers of black locust can be useful for public safety, for example, next to ramps, steeper shores of strip-mine lakes, roadways, and industrial sites. They help prevent access by off-road vehicles or other trespass into reclaimed fields or forest plantings. The barrier can be renewed and maintained parallel to the areas of interest by harvesting alternate strips for biomass and to bring about sprout production.

Profuse flowering by black locust provides springtime color. The flowers are eagerly sought by bees and furnish pollen and nectar that contribute to the buildup of bee populations and honey production later in the season. Locust trees planted along the edge of an alfalfa or clover pasture provide early-season support to bee populations.

Wildlife values of black locust are variable. Its rapidly developing cover contributes to habitat for numerous birds and mammals. Locust is a good producer of seed that is a major food resource for quail in winter.

Benefits and Problems Using Black Locust

Mining permits or reclamation plans are prepared to fit site and land-use requirements of each mine. The overall desirability of using black locust will depend both on site conditions and on the projected postmining land use. The following is a summary of many of the potential benefits and problems from including black locust in reclamation planning and plantings.

Potential Benefits

1. Can be planted as seed or seedling; both are readily available and relatively inexpensive.
2. Is adapted to a wide range of climatic and soil (spoil) conditions.
3. Usually grows faster than other kinds of trees the first several years after planting.
4. Survives well in competition with grasses and other herbaceous cover.
5. Promotes soil permeability and water entry which in turn decreases surface runoff and erosion.
6. Has root nodules with bacteria that fix nitrogen symbiotically.
7. Produces leaf and woody litter that contributes to rapid building of soil organic matter and cycling and availability of nutrients.

8. Will spread by root suckers in coal slurry and other unstable rooting media, resulting in dust and erosion control.
9. Produces quick cover and screening for erosion control and landscape and esthetic enhancement.
10. Young dense stands can furnish an effective barrier against trespass or entry to other plantings and hazardous areas.
11. Produces large quantities of cordwood for fuel or charcoal.
12. Produces substantial biomass with early regrowth from root suckers and stump sprouts after cutting.
13. Under favorable growth conditions, provides short-term production of cordwood or durable fenceposts.
14. Afford habitat for several kinds of wildlife. Seed is prime food for quail in some regions.
15. Supports bee colonies and honey production by early spring flowering.
16. Natural release of interplanted or underplanted timber trees can result from borer attack or other causes of locust mortality.
3. May be too competitive where planted with other trees in mixed stands. This problem can be alleviated by choosing suitable percentages of locust in the mix, suitable spacings between trees, and suitable timing of plantings.
4. Cannot grow under shade.
5. In some plantings, especially on poorer sites, locust borer often destroys the commercial potential for fenceposts and firewood.
6. Unless controlled by management, vigorous sprouting after intensive cutting reduces the chance to introduce more valuable trees.
7. Spreads into adjacent unmanaged open areas.

These benefits and problems encompass a range of potential uses both on lands newly mined and on older mining operations still needing revegetation. A new era for use of black locust has opened with the need to overcome limitations of compaction on graded minesoils. Its vigorous root-system is useful for improving soil physical and chemical conditions prior to development of agricultural row-crop production. Black locust has the potential to contribute significantly to accelerated forest development within the framework of current regulatory requirements. This species remains a valuable biological resource for meeting diverse needs in reclamation. If full advantage is taken of this potential resource, the reclamation equation will include the planting of millions more black locust seedlings and seed in the years to come.

Potential Problems

1. Pure stands, particularly direct-seeded ones, are nearly impenetrable during the thicket stage from about age 2 to 8.
2. Thorns can be a hazard to people and equipment when underplanting or harvesting.

Literature Cited

- shby, William C.; Baker, Malchus B., Jr.; Casteel, John B. **Forest cover changes in strip mine plantings.** Tree Planters notes. 76: 17-20; 1966.
- shby, W. Clark; Kolar, Clay A. **A 30-year record of tree growth in strip mine plantings.** Tree Planters Notes. 28(3,4): 18-21, 31; 1977.
- shby, W. Clark; Rogers, Nelson F.; Kolar, Clay A. **Forest tree invasion and diversity on strip mines.** In: Garrett, H. E.; Cox, G. S., eds. Proceedings, central hardwood forest conference III; 1980 September 16-17; Columbia, MO. Columbia, MO: University of Missouri Press; 1980: 273-281.
- byce, Stephen G.; Merz, Robert W. **Tree species recommended for strip-mine plantations in western Kentucky.** Tech. Pap. 160. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station; 1959. 12 p.
- byce, Stephen G.; Neebe, David J. **Trees for planting on strip-mined land in Illinois.** Tech. Pap. 164. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station; 1959. 33 p.
- own, James H. **Height growth prediction for black locust on surface-mined areas in West Virginia.** Agric. Exp. Stn. Bull. 617. Morgantown, WV: West Virginia University; 1973. 11 p.
- urmean, Willard H.; Clark, F. Bryan; Williams, Robert D.; Hannah, Peter R. **Hardwoods planted in old fields favored by prior tree cover.** Res. Pap. NC-134. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1976. 16 p.
- Carpenter, Stanley B.; Eigel, Robert A. **Reclaiming surface mines with black locust fuel plantations.** In: Proceedings, Canadian Land Reclamation Association 4th annual meeting; 1979 August 13-15; Regina, Saskatchewan, Canada. Guelph, Ontario Canada: Canadian Land Reclamation Association; 1979: 239-253.
- Czapowskyj, Miroslaw M. **Experimental planting of 14 tree species on Pennsylvania's anthracite strip-mine spoils.** Res. Pap. NE-155. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1970. 18 p.
- Davidson, Walter H. **Deer prefer pine seedlings growing near black locust.** Res. Note NE-111. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1970. 4 p.
- Davidson, Walter H. **Results of tree and shrub plantings on low pH stripmine banks.** Res. Note NE-285. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1979. 5 p.
- Eigel, Robert A.; Wittwer, Robert F.; Carpenter, S. B. **Biomass and nutrient accumulation in young black locust stands established by direct seeding on surface mines in eastern Kentucky.** In: Garrett, H. E.; Cox, G. S., eds. Proceedings, central hardwood forest conference III; 1980 September 16-17; Columbia, MO. Columbia, MO: University of Missouri Press; 1980: 337-346.
- Finn, Raymond F. **Ten years of strip mine forestation research in Ohio.** Tech. Pap. 153. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station; 1958. 38 p.
- Finn, Raymond F.; Limstrom, Gustaf A. **Black locust sprouts also susceptible to borer attacks.** Stn. Note No. 101. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station; 1957. 2 p.
- Hall, Ralph C. **Suggestions for locust borer control.** Stn. Note 5. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station; 1933. 5 p.
- Hart, George; Byrnes, William. R. **Trees on strip-mined lands.** Stn. Pap. 136. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1960. 36 p.
- Hoffard, William H.; Anderson, Robert L. **A guide to common insects, diseases and other problems of black locust.** For. Rep. SA-FR-19, Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area; 1982. 9 p.
- Kellogg, L. F. **Failure of black locust-coniferous mixtures in the central states.** Stn. Note 15. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station; 1936. 4 p.
- Larson, M. M. **Invasion of volunteer tree species on stripmine plantations in east-central Ohio.** Res. Bull. 1158. Wooster, OH: Ohio State University, Ohio Agricultural Research and Development Center; 1984. 10 p.
- Larson, M. M.; Vimmerstedt, J. P. **Evaluation of 30-year-old plantations on stripmined land in east**

- central Ohio.** Res. Bull. 1149. Wooster, OH: Ohio State University, Ohio Agricultural Research and Development Center; 1983. 20 p.
- Limstrom, G. A. **Forestation of strip-mined land in the central states.** Agric. Handb. 166. Washington, DC: U.S. Department of Agriculture; 1960. 74 p.
- Naughton, G. G. **The University of Kansas energy forest.** Final report to the Ozarks Regional Commission; Agreement No. DEM-AGR 76-50(N). Manhattan, KS: Kansas State University, Department of Forestry; 1980. 74 p.
- Plass, William T. **Fertilization treatments increase black locust growth on extremely acid surface mine spoils.** Tree Planters Notes. 23(4): 10-12; 1972.
- Roberts, D. R.; Carpenter, S. B. **The influence of seed scarification and site preparation on establishment of black locust on surface-mined sites.** Tree Planters Notes 34(3): 28-30; 1983.
- Rogers, Nelson F. **Strip-mined lands of the Western Interior Coal Province.** Res. Bull. 475. Columbia, MO: University of Missouri, Agricultural Experiment Station; 1951. 55 p.
- U.S. Department of Agriculture, Forest Service. **Enjoy your fireplace, especially during the energy crisis.** Upper Darby, PA: U.S. Department of Agriculture, Forest Service, n.d., Brochure. 7 p.
- Vogel, Willis G. **Revegetation of surface-mined lands in the east.** In: Proceedings, 1977 Society of American foresters annual meeting; 1977 October 2-5; Albuquerque, NM. Washington, DC: Society of American Foresters; 1977: 167-172.
- Vogel, Willis G. **A guide for revegetating coal minesoils in the eastern United States.** Gen. Tech. Rep. NE-68. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1981. 190 p.
- Vogel, Willis G.; Berg, William A. **Fertilizer and herbaceous cover influence establishment of direct-seeded black locust on coal-mine spoils.** In: Hutnik, R. J.; Davis, G. eds. Ecology and reclamation of devastated land, Vol. 2. New York: Gordon and Breach; 1973: 189-193.
- White, T. A.; Rolfe, G. L. **A test of tolerance: 1982 greenhouse herbicide trials with direct-seeded black locust.** For. Res. Rep. No. 83-2. Urbana, IL: University of Illinois, Department of Forestry; 1983. 5 p.

Ashby, W. Clark; Vogel, Willis G.; Rogers, Nelson F. **Black locust in the reclamation equation.** Gen. Tech. Rep. NE-105. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 12 p.

Black locust has been planted and seeded more than any other tree species on lands surface-mined for coal in the Eastern United States. Benefits from planting black locust are: it provides quick cover for stabilization and esthetics; it supplies nitrogen and nutrient-rich litter to soil; it improves site for establishment of other higher quality trees; it grows in a wide range of minesoil conditions, including extremely acid soils; it grows better than most trees in soils compacted by grading and topsoiling practices; it can be established by seeding, and it is useful for posts, fuel, and biomass production.

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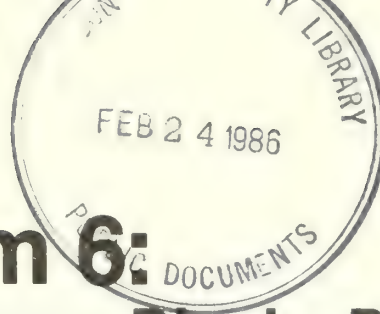
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Northeastern Forest
Experiment Station

General Technical
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System 6: Chips Versus Blanks Program

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Abstract

This paper gives a computer program to be used on the IBM-PC to evaluate the tradeoff between chips and boards. In System 6, bolts are sawed to cants, and cants are resawed to boards. All boards with a minimum clear area are stacked, dried, and processed to blanks. All other boards are chipped. When the bolts are of poor quality, many boards will have only the minimum clear area. By increasing the size of the minimum clear area used in sorting, only the better boards will be used for blanks and more chips will be made. Additional cants will have to be purchased to replace the boards chipped.

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The computer program described in this publication is available on request with the understanding that the U.S. Department of Agriculture cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program.

System 6 is a new technology (Reynolds and Mitchell 1982) to convert small-diameter, low-grade roundwood timber to standard-size blanks. Blanks are edge-glued panels (Araman et al. 1982) used to make furniture and kitchen cabinet parts.

In System 6, the tree stem is bucked to 6- or 8-foot-long bolts, the bolts are sawed to cants, and the cants are resawed to boards. The boards that do not have at least one minimum cutting (1-1/2 by 15 inches) are chipped. All other boards are stacked for drying. After drying, all boards are processed to blanks.

It is assumed that the reader is familiar with System 6 rough-mill operating procedures (Reynolds 1984).

Operating the Rough Mill

In making a System 6 rough mill run, the wood species, blank thickness, and blank quality to be made are specified. Boards of the correct species and thickness are used. Boards are not graded. Every board must contain at least a 1-1/2- by 15-inch piece because this was the criterion used to choose the boards to be used. All of these boards are processed.

System 6 rough mill runs are preplanned. Board-grade data per operating method (GCL's—gang cross-length) and blank requirements per length (cutting bills) are put through a linear program (LP). The LP solution gives the minimum quantity of boards to be made up by each GCL to satisfy the cutting bill requirements. When board quality is good, yields are high and only a few short blanks are made. When board quality

level is poor, yields are low and many short blanks are made. Board quality and cutting bill requirements will both affect the LP solution.

When board quality level is high and few long blanks are required in the cutting bill, yields will be high. If board quality levels are low and many long blanks are required in the cutting bill, yields will be low. This will cause profits to suffer. Since the cutting bill requirements are set by customer demands, only the board quality level can be controlled by the System 6 operator. Better quality timber should be purchased, if possible, when cutting bills require many long blanks.

When poor-quality timber must be used and many long blanks are needed, the green-board sorting criteria after cant resawing must be changed. By increasing the size of the minimum clear area, fewer boards will be sent to the stacker from the cant gang resaw. The quality level of the dried boards will be better and more long blanks will be made.

When sorting to get higher quality boards, a trade-off must be made. The chips versus blanks program is used to resolve this tradeoff (Appendix). Chips are much less valuable than blanks. However, by chipping more boards, more chips are made and more money is realized from the sale of chips. On the other hand, additional timber must be purchased to produce enough of the better quality boards to keep the rough mill operating at full capacity. The program is used to resolve whether the value of the additional chips and blanks of shorter lengths that are in excess of cutting bill requirements offsets the cost of the additional roundwood.

Input Data Required

Eleven variables must be known or estimated to create a meaningful input to solve the chips versus blanks tradeoff.

1. **Board input per shift:** The System 6 rough mill is designed to process a given input of boards per shift. The input board quality will affect the blank output. Poor-quality boards will produce fewer blanks while good-quality boards will produce more. The input board quantity is based on board quality and is determined in a pretest. Board quantity is a function of mill design and must be stated.
2. **Cash flow-in:** The System 6 mill operator is expected to earn a given amount of money per year to meet the owner's earnings requirement. This annual cash flow-in requirement is placed on a per shift basis. The per shift cash flow-in is a function of the mill business design and must be stated (Hansen & Reynolds 1984).
3. **Percent boards chipped:** This is the percentage of boards, by board feet measure, sent to the chipper when sorting for higher quality boards. The remainder of the boards go to the stacker for drying. When sorting for higher quality boards is not done, this value is zero.
4. **Chip price:** This is the amount per green ton the chips are sold for f.o.b. (free on board) the System 6 mill.
5. **Cant cost (chip replacement):** This is the cost, per M bf (thousand board feet), to be paid for the additional cants that are required to make up for the board footage sent to the chipper.
6. **Required blanks yield:** This is the yield, in percent blanks surface area, of the blanks required by the cutting bill.
7. **Extra blanks yield:** In some instances, more blanks that are less than 50 inches long but longer than 20 inches, are made than are required by the cutting bill. These blanks accumulate, as the 50 inch and longer blanks are made, and must be sold.
8. **Excess salvage blanks yield:** In System 6, blanks 20 inches or shorter are made on a salvage basis. If these blanks accumulate up to the quantity stated in the cutting bill, they are accepted. If more than the cutting bill quantity is made, they are excess and must be sold.

9. **Required blanks price:** This is the average price, per square foot surface area, of the blanks required by the cutting bill.
10. **Extra blanks price:** Since the extra blanks are of the same quality as the required blanks, they can be sold. However, a lower price will probably have to be used to create a new market and sell them promptly.
11. **Excess salvage blanks price:** These blanks are also of the required blanks quality. But due to their short length, a much lower price will have to be used to sell them promptly.

Using The Program

Program CHVBL1.BAS, Appendix, must be loaded onto a diskette containing the COMMAND.COM, ANSI.SYS, SYS.COM, PRINT.COM, FIND.EXE, and BASICA.COM DOS files. This diskette is put into drive A. A formatted disk, as a scratch file, must be put into drive B. First enter BASICA then LOAD "A:CHVBL1.BAS" to put the program into memory. F8 starts the program. The program has an associated data file, "B:CHVBL1.DAT". The input data from a run is saved and is entered as input data for the next run. This "old" data is changed to be the "new" data for that run. Only the data changed need be entered.

When the program is first run, there will be no CHVBL1.DAT file on the B diskette. Program lines 80, 90, and 100 must be deleted with the program in memory. All 11 data lines are entered during this first run. The CHVBL1.DAT file will be entered on the B diskette during this first run. Then on the second run the program must be reloaded so that lines 80, 90, and 100 are available and the data from a run is read as "old" data for the next run.

The program is written with prompting messages so data entry and use are simple and quick. We recommend no more than 70 characters or spaces on the identification line. If more description is used, the list will scroll and not all data will appear on the screen when the solution is given.

Program Demonstrations

Input data for demonstration run 1 is taken from the standard mill option by Hansen and Reynolds (1984) as follows:

The System 6 mill will process 16 M bf per shift.

Normal operations bring in \$11,520 per shift.

No boards will be chipped except those not meeting the minimum 1-1/2- by 15-inch clear area requirement.

Chip price is \$0 per ton.

Since no boards are to be chipped, this value is not used in this run, so cant cost = \$0.

For the cutting bill and the quality of boards used, yield in blanks required by the cutting bill is 45.0 percent.

There is no additional yield in extra blanks.

There is no additional yield in salvage length blanks.

Required blanks will sell for an average price of \$1.60 per square foot.

Extra blanks will sell for an average price of \$1.20 per square foot.

Extra salvage blanks will sell for an average price of \$0.80 per square foot.

Results are given in two ways (Figure 1): (1) Cash flow-in as a result of operating the System 6 mill as described by the input data, and (2) blank prices needed to meet the \$11,520 cash flow-in required.

There was \$11,520 realized from the sale of the 200 square feet of blanks made and sold at \$1.60 per square foot. As there were no other earnings or costs, the \$11,520 matched the required cash flow. The prices calculated were the same as the prices given as input data.

Then the cutting bill was changed so that more blanks were required, but the same quality boards were used. The yield of required blanks fell to 35 percent, but there was a 3.5 percent yield of shorter blanks in excess of requirements. There was also a 1.5 percent yield of blanks less than 20 inches long (the salvage blanks).

As shown in Figure 2, 5,600 square feet of required blanks realized \$8,960 at \$1.60 per square foot. The extra blanks brought in \$672, and the salvage blanks brought in \$192. The total cash flow-in was \$9,824 which was \$1,696 short of the \$11,520 cash flow-in required by the System 6 mill business plan. So, to earn the additional \$1,696, the required blanks price had to be raised 28 cents per square foot to \$1.88, the extra blanks 21 cents per square foot to \$1.41, and the salvage blanks 14 cents per square foot to \$0.94.

If, however, we had chipped 20 percent of the poorest boards when we ran the second cutting bill, the overall board quality for blanks would have improved and yields would have risen. There would have been a 42.5 percent yield of required blanks, a 2.0 percent yield of extra blanks, and a 0.5 percent yield of excess salvage blanks.

As shown in Figure 3, 6,800 square feet of required blanks realized \$10,880 at \$1.60 per square foot. The 320 square feet of extra blanks were worth \$384 at \$1.20 per square foot, and 80 square feet of salvage blanks were worth \$64 at \$0.80 per square foot. An additional \$80 was raised from chips made from the 20 percent poor-quality boards, but \$576 had to be spent for cants to replace those boards. At this point, total cash flow of \$10,832 is \$688 shy of the \$11,520 goal. This \$688 is raised by increasing the required blanks price by 10 cents per square foot, the extra blanks by 7 cents per square foot, and the salvage blanks by 5 cents per square foot.

Look at the System 6 mill operations another way and return to Figure 1. For the cutting bill requirements used, a 45 percent yield of required blanks was obtained and no extra or excess salvage blanks were made. If we had chipped 20 percent of all boards as they left the cant gang resaw, the board quality would have improved to give a 48 percent yield of required blanks.

Figure 4 shows the effect that chipping 20 percent of the green boards and replacing them from cants costing \$190 per M bf will have on the blank price and cash flow-in. There will be \$240 more coming in when \$1.60 per square foot is charged. The mill operator can pocket this additional profit or pass the savings on to customers by reducing the blank price by 3 cents per square foot.

CHIPS Vs BLANKS Program 1

04-08-

Poorest boards chipped; all blanks sold

11:28:

Input Data			
1 Board input per shift	16.00mbf	6 Req'd blanks yield=	45.
2 Cash flow req'd=	\$11,520.00	7 Extra blanks yield=	0.
3 Percent boards chipped=	0.0%	8 Exc salv blanks yield=	0.
4 Chip price=	\$ 0.00/ton	9 Req'd blanks price	\$ 1.
5 Cant cost(chip repl)=	\$ 0.00/mbf	10 Extra blanks price	\$ 1.
		11 Exc salv blanks price=	\$ 0.

RUN IDENT:DEMONSTRATION #1

Output Values: Cash Flow In

Required blanks made=	7,200sqft	Value	\$11,520
Extra blanks made=	0sqft	Value	\$ 0
Exc sal blanks made=	0sqft	Value	\$ 0
Chips made=	0.00tons	Value	\$ 0
Additional cants for chips=	0.00mbf	Value	\$ 0
Total cash flow in (Excess/shortage \$	0)		\$11,520

Output Values: Blank Prices

Required blanks made=	7,200sqft	Value	\$11,520
Extra blanks made=	0sqft	Value	\$ 0
Exc sal blanks made=	0sqft	Value	\$ 0
Chips made=	0.00tons	Value	\$ 0
Additional cants for chips=	0.00mbf	Value	\$ 0
Total cash flow in (Equal cash flow req'd)			\$11,520
Req'd Blanks Price=	\$ 1.60/sqft		
Extra Blanks Price=	\$ 1.20/sqft		
Exc Sal Blanks Price=	\$ 0.80/sqft		

Figure 1.--Program CHVBL1 output: Run No. 1

CHIPS Vs BLANKS Program 1

04-08-1985

Poorest boards chipped; all blanks sold

11:30:53

Input Data

Board input per shift	16.00mbf	6 Req'd blanks yield=	35.0%
Cash flow req'd=	\$11,520.00	7 Extra blanks yield=	3.5%
Percent boards chipped=	0.0%	8 Exc salv blanks yield=	1.5%
Chip price=	\$ 0.00/ton	9 Req'd blanks price	\$ 1.60
Cant cost(chip repl)=	\$ 0.00/mbf	10 Extra blanks price	\$ 1.20
		11 Exc salv blanks price=	\$ 0.80

IDENT:DEMONSTRATION #2

Output Values: Cash Flow In

Required blanks made=	5,600sqft	Value \$	8,960
Extra blanks made=	560sqft	Value \$	672
Exc sal blanks made=	240sqft	Value \$	192
Chips made=	0.00tons	Value \$	0
Additional cants for chips=	0.00mbf	Value \$	0
Total cash flow in (Excess/shortage \$-1,696)			\$ 9,824

Output Values: Blank Prices

Required blanks made=	5,600sqft	Value \$	10,507
Extra blanks made=	560sqft	Value \$	788
Exc sal blanks made=	240sqft	Value \$	225
Chips made=	0.00tons	Value \$	0
Additional cants for chips=	0.00mbf	Value \$	0
Total cash flow in (Equal cash flow req'd)			\$11,520
Req'd Blanks Price=	\$ 1.88/sqft		
Extra Blanks Price=	\$ 1.41/sqft		
Exc Sal Blanks Price=	\$ 0.94/sqft		

Figure 2.--Program CHVBL1 output: Run No. 2

CHIPS Vs BLANKS Program 1

04-08-1980

Poorest boards chipped; all blanks sold

11:06:53

Input Data

1 Board input per shift	16.00mbf	6 Req'd blanks yield=	42.5%
2 Cash flow req'd=	\$11,520.00	7 Extra blanks yield=	2.0%
3 Percent boards chipped=	20.0%	8 Exc salv blanks yield=	0.5%
4 Chip price=	\$ 10.00/ton	9 Req'd blanks price	\$ 1.60/sqft
5 Cant cost(chip repl)=	\$180.00/mbf	10 Extra blanks price	\$ 1.27/sqft
		11 Exc salv blanks price=	\$ 0.85/sqft

RUN IDENT:DEMONSTRATION #3

Output Values: Cash Flow In

Required blanks made=	6,800sqft	Value	\$10,880
Extra blanks made=	320sqft	Value	\$ 384
Exc sal blanks made=	80sqft	Value	\$ 64
Chips made=	8.00tons	Value	\$ 80
Additional cants for chips=	3.20mbf	Value	\$ -576
Total cash flow in (Excess/shortage \$ -688)			\$10,832

Output Values: Blank Prices

Required blanks made=	6,800sqft	Value	\$11,541
Extra blanks made=	320sqft	Value	\$ 407
Exc sal blanks made=	80sqft	Value	\$ 68
Chips made=	8.00tons	Value	\$ 80
Additional cants for chips=	3.20mbf	Value	\$ -576
Total cash flow in (Equal cash flow req'd)			\$11,520
Req'd Blanks Price=	\$ 1.70/sqft		
Extra Blanks Price=	\$ 1.27/sqft		
Exc Sal Blanks Price=	\$ 0.85/sqft		

Figure 3.--Program CHVBL1 output: Run No. 3

CHIPS Vs BLANKS Program 1

04-08-1985

Poorest boards chipped; all blanks sold

11:11:36

Input Data

1 Board input per shift	16.00mbf	6 Req'd blanks yield=	48.0%
2 Cash flow req'd=	\$11,520.00	7 Extra blanks yield=	0.0%
3 Percent boards chipped=	20.0%	8 Exc salv blanks yield=	0.0%
4 Chip price=	\$ 10.00/ton	9 Req'd blanks price	\$ 1.60
5 Cant cost(chip repl)=	\$190.00/mbf	10 Extra blanks price	\$ 1.20
		11 Exc salv blanks price=	\$ 0.80

IDENT:DEMONSTRATION #4

Output Values: Cash Flow In

Required blanks made=	7,680sqft	Value	\$12,288
Extra blanks made=	0sqft	Value	\$ 0
Exc sal blanks made=	0sqft	Value	\$ 0
Chips made=	8.00tons	Value	\$ 80
Additional cants for chips=	3.20mbf	Value	\$ -608
Total cash flow in (Excess/shortage \$ 240)			\$11,760

Output Values: Blank Prices

Required blanks made=	7,680sqft	Value	\$12,048
Extra blanks made=	0sqft	Value	\$ 0
Exc sal blanks made=	0sqft	Value	\$ 0
Chips made=	8.00tons	Value	\$ 80
Additional cants for chips=	3.20mbf	Value	\$ -608
Total cash flow in (Equal cash flow req'd)			\$11,520
Req'd Blanks Price=	\$ 1.57/sqft		
Extra Blanks Price=	\$ 1.18/sqft		
Exc Sal Blanks Price=	\$ 0.78/sqft		

Figure 4.--Program CHVBL1 output: Run No. 4

Conclusions

When chips can be sold and additional cants can be purchased, profit opportunities arise for the System 6 mill manager. By chipping some of the poorest green boards, the boards sent through the mill are of a higher quality level. Thus, total yields increase and the quantity of long blanks increases. A wide range of cutting bills can be made at the System 6 mill with only slight increases in blank prices.

When board quality is at a normal or low level, chipping some of the poorest green boards will raise the average dry board quality. Total yields will rise and profits will increase if the additional cant price is not excessive.

Since each set of the 11 input variables will result in different outputs, general statements are difficult to make. Instead, we have provided this IBM-PC program to be used to make calculations easily and quickly.

Literature Cited

Araman, Philip A.; Gatchell, Charles J.; Reynolds, Hugh W. **Meeting the solid wood needs of the furniture and kitchen cabinet industries: standard-size hardwood blanks.** Res. Pap. NE-494. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982. 27 p.

Hansen, Bruce G.; Reynolds, Hugh W. **System 6 alternatives: An economic analysis.** Res. Pap. NE-551. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 14 p.

Reynolds, Hugh W. **System 6: Rough mill operating manual.** Res. Pap. NE-542. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 27 p.

Reynolds, Hugh W.; Gatchell, Charles J. **New technology for low-grade hardwood utilization: System 6.** Res. Pap. NE-504. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982. 8 p.

ppendix

```

0 REM This program will calculate either (1) the cash flow in per shift for a
0 REM given cutting bill, chip %, & blank prices; or (2) the blank prices
0 REM req'd for a specified cash flow with a given cutting bill & chip %.
0 REM It is written in BASICA for the IBM PC & is saved as "A:CHVBL1.BAS".
0 CLS
0 KEY OFF
0 DEFINT N
0 OPEN "B:CHVBL1.DAT" FOR INPUT AS #1
0 INPUT #1, CFIR,YRB,YEB,YESB,RBP,EBP,ESBP,PBC,CC,CP,BIPS
00 CLOSE #1
10 N=0
20 ID1$=" 2 Cash flow req'd= $$$,###.## "
30 ID2$=" 6 Req'd blanks yield= ##.##%"
40 ID3$=" 7 Extra blanks yield= ##.##%"
50 ID4$=" 8 Exc salv blanks yield= ##.##%"
60 ID5$=" 9 Req'd blanks price $###.##"
70 ID6$=" 10 Extra blanks price $###.##"
80 ID7$=" 11 Exc salv blanks price= $###.##"
90 ID8$=" 3 Percent boards chipped= ##.##%"
00 ID9$=" 5 Cant cost(chip repl)= $###.##/mbf"
10 ID10$=" 4 Chip price= $###.##/ton"
20 ID11$=" 1 Board input per shift ##.##mbf "
30 CLS
40 PRINT: PRINT:
50 PRINT TAB(10) "CHIPS Vs BLANKS Program 1": PRINT
60 PRINT "Poorest boards chipped; all blanks sold": PRINT
70 PRINT TAB(15) "Input Data"
80 PRINT USING ID11$; BIPS
90 PRINT USING ID1$; CFIR
00 PRINT USING ID8$; PBC
10 PRINT USING ID10$; CP
20 PRINT USING ID9$; CC
30 PRINT USING ID2$; YRB
40 PRINT USING ID3$; YEB
50 PRINT USING ID4$; YESB
60 PRINT USING ID5$; RBP
70 PRINT USING ID6$; EBP
80 PRINT USING ID7$; ESBP
90 PRINT " 13 To solve using this data enter 13,13": PRINT
00 INPUT "ENTER NUMBER AND DATA VALUE FOR CHANGES"; N,DUM
10 IF N=1 THEN BIPS=DUM ELSE 430
20 GOTO 400
30 IF N=2 THEN CFIR=DUM ELSE 450
40 GOTO 400
50 IF N=3 THEN PBC=DUM ELSE 470
60 GOTO 400
70 IF N=4 THEN CP=DUM ELSE 490
80 GOTO 400
90 IF N=5 THEN CC=DUM ELSE 510
00 GOTO 400

```

```

510 IF N=6 THEN YRB=DUM ELSE 530
520 GOTO 400
530 IF N=7 THEN YEB=DUM ELSE 550
540 GOTO 400
550 IF N=8 THEN YESB=DUM ELSE 570
560 GOTO 400
570 IF N=9 THEN RBP=DUM ELSE 590
580 GOTO 400
590 IF N=10 THEN EBP=DUM ELSE 610
600 GOTO 400
610 IF N=11 THEN ESBP=DUM ELSE 630
620 GOTO 400
630 IF N>12 GOTO 640
640 OPEN "B:CHVBL1.DAT" FOR OUTPUT AS #1
650 PRINT #1, CFIR;YRB;YEB;YESB;RBP;EBP;ESBP;PBC;CC;CP;BIPS
660 CLOSE #1
670 RBM=BIPS*1000*(YRB/100)
680 EBM=BIPS*1000*(YEB/100)
690 ESBM=BIPS*1000*(YESB/100)
700 CFIC=CP*2.5*BIPS*(PBC/100)
710 CFIRB=RBM*RBP
720 CFIEB=EBM*EBP
730 CFIESB=ESBM*ESBP
740 CFOAB=(BIPS*(PBC/100)*CC)*(-1)
750 TCFI=CFIRB+CFIEB+CFIESB+CFIC+CFOAB
760 CRBP=(CFIR-CFOAB-CFIC)/(RBM+(EBP/RBP*EBM)+(ESBP/RBP*ESBM))
770 CEBP=(EBP/RBP)*CRBP
780 CESBP=(ESBP/RBP)*CRBP
790 TCM=BIPS*(PBC/100)*2.5
800 ABR=BIPS*(PBC/100)
810 CCFIRB=RBM*CRBP
820 CCFIEB=EBM*CEBP
830 CCFIESB=ESBM*CESBP
840 CTCFI=CCFIRB+CCFIEB+CCFIESB+CFIC+CFOAB
850 CFES=TCFI-CFIR
860 D$=DATE$: T$=TIME$
870 OD1$="      Required blanks made=      ###,###sqft"
880 OD2$="      Value $##,###"
890 OD21$="      Value $##,###"
900 OD4$="      Exc sal blanks made=      ###,###sqft"
910 OD3$="      Extra blanks made=      ###,###sqft"
920 OD10$="      Req'd Blanks Price= $##.##/sqft"
930 OD11$="      Extra Blanks Price= $##.##/sqft"
940 OD12$="      Exc Sal Blanks Price=$##.##/sqft"
950 OD5$="      Chips made=      ##.##tons"
960 OD6$="      Total cash flow in (Excess/shortage $##,###)"
970 OD9$="      Additional cants for chips=      ##.##mbf"
980 OD13$="      $##,###"
990 OD14$="      Total cash flow in (Equal cash flow req'd)      $##,###"
1000 CLS

```

```

1010 PRINT
1020 PRINT TAB(20) "CHIPS Vs BLANKS Program 1";
1030 PRINT TAB(30) "Input Data"
1040 PRINT USING ID11$; BIPS;
1050 PRINT USING ID2$; YRB
1060 PRINT USING ID1$; CFIR;
1070 PRINT USING ID3$; YEB
1080 PRINT USING ID8$; PBC;
1090 PRINT USING ID4$; YESB
1100 PRINT USING ID10$; CP;
1110 PRINT USING ID5$; RBP
1120 PRINT USING ID9$; CC;
1130 PRINT USING ID6$; EBP
1140 PRINT TAB(39);
1150 PRINT USING ID7$; ESBP
1160 INPUT "RUN IDENT:"; RD$
1170 PRINT TAB(25) "Output Values: Cash Flow In"
1180 PRINT USING OD1$; RBM;
1190 PRINT USING OD2$; CFIRB
1200 PRINT USING OD3$; EBM;
1210 PRINT USING OD2$; CFIEB
1220 PRINT USING OD4$; ESBM;
1230 PRINT USING OD2$; CFIESB
1240 PRINT USING OD5$; TCM;
1250 PRINT USING OD2$; CFIC
1260 PRINT USING OD9$; ABR;
1270 PRINT USING OD21$; CFOAB
1280 PRINT USING OD6$; CFES;
1290 PRINT USING OD13$; TCFI
1300 PRINT TAB(25) "Output Values: Blank Prices"
1310 PRINT USING OD1$; RBM;
1320 PRINT USING OD2$; CCFIRB
1330 PRINT USING OD3$; EBM;
1340 PRINT USING OD2$; CCFIEB
1350 PRINT USING OD4$; ESBM;
1360 PRINT USING OD2$; CCFIESB
1370 PRINT USING OD5$; TCM;
1380 PRINT USING OD2$; CFIC
1390 PRINT USING OD9$; ABR;
1400 PRINT USING OD21$; CFOAB
1410 PRINT USING OD14$; CTCFI
1420 PRINT USING OD10$; CRBP;
1430 PRINT USING OD11$; CEBP
1440 PRINT USING OD12$; CESBP
1450 INPUT "ENTER 1 TO PRINT. ENTER 2 FOR NEW RUN"; NN
1460 IF NN=1 THEN 1480 ELSE 1470
1470 RUN 50
1480 LPRINT: LPRINT: LPRINT
1490 LPRINT TAB(20) "CHIPS Vs BLANKS Program 1";
1500 LPRINT TAB(65) D$

```

```

1510 LPRINT
1520 LPRINT TAB(15) "Poorest boards chipped; all blanks sold";
1530 LPRINT TAB(65) T$
1540 LPRINT: LPRINT
1550 LPRINT TAB(30) "Input Data"
1560 LPRINT USING ID11$; BIPS;
1570 LPRINT USING ID2$; YRB
1580 LPRINT USING ID1$; CFIR;
1590 LPRINT USING ID3$; YEB
1600 LPRINT USING ID8$; PBC;
1610 LPRINT USING ID4$; YESB
1620 LPRINT USING ID10$; CP;
1630 LPRINT USING ID5$; RBP
1640 LPRINT USING ID9$; CC;
1650 LPRINT USING ID6$; EBP
1660 LPRINT TAB(39);
1670 LPRINT USING ID7$; ESBP
1680 LPRINT
1690 LPRINT "RUN IDENT:"; RD$
1700 LPRINT
1710 LPRINT TAB(25) "Output Values: Cash Flow In"
1720 LPRINT USING OD1$; RBM;
1730 LPRINT USING OD2$; CFIRB
1740 LPRINT USING OD3$; EBM;
1750 LPRINT USING OD2$; CFIEB
1760 LPRINT USING OD4$; ESBM;
1770 LPRINT USING OD2$; CFIESB
1780 LPRINT USING OD5$; TCM;
1790 LPRINT USING OD2$; CFIC
1800 LPRINT USING OD9$; ABR;
1810 LPRINT USING OD21$; CFOAB
1820 LPRINT USING OD6$; CFES;
1830 LPRINT USING OD13$; TCFI
1840 LPRINT
1850 LPRINT TAB(25) "Output Values: Blank Prices"
1860 LPRINT USING OD1$; RBM;
1870 LPRINT USING OD2$; CCFIRB
1880 LPRINT USING OD3$; EBM;
1890 LPRINT USING OD2$; CCFIEB
1900 LPRINT USING OD4$; ESBM;
1910 LPRINT USING OD2$; CCFIESB
1920 LPRINT USING OD5$; TCM;
1930 LPRINT USING OD2$; CFIC
1940 LPRINT USING OD9$; ABR;
1950 LPRINT USING OD21$; CFOAB
1960 LPRINT USING OD14$; CTCFI
1970 LPRINT USING OD10$; CRBP
1980 LPRINT USING OD11$; CEBP
1990 LPRINT USING OD12$; CESBP
2000 LPRINT CHR$(12)
2010 GOTO 1450
2020 END

```

Reynolds, Hugh W. **System 6: Chips versus blanks program.** Gen. Tech. Rep. NE-106. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 12 p.

This paper gives a computer program to be used on the IBM-PC to evaluate the tradeoff between chips and boards. In System 6, bolts are sawed to cants, and cants are resawed to boards. All boards with a minimum clear area are stacked, dried, and processed to blanks. All other boards are chipped. When the bolts are of poor quality, many boards will have only the minimum clear area. By increasing the size of the minimum clear area used in sorting, only the better boards will be used for blanks and more chips will be made. Additional cants will have to be purchased to replace the boards chipped.

ODC 836.1; 847.1/2

Keywords: Low-grade utilization, hardwood dimension

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-



Program BLANKS on the IBM-PC

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Abstract

Describes a computer program that allows a company to determine the number of edge-glued, standard-size blanks needed to satisfy the rough-part needs specified in a given cutting bill. Program BLANKS has been written in FORTRAN using 80 column card input for use on a mainframe computer. The program has been translated to BASICA for use on the IBM-PC. Also described are rough-part cutting bill input file creation and sorting programs. A sample rough-part cutting bill and a blanks analysis are included.

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Introduction

Blanks are standard-size, edge-glued, solid hardwood panels used to make rough-dimension parts. The blanks concept and standard sizes have been developed at the Forestry Sciences Laboratory in Princeton, West Virginia (Araman et al. 1982). Blanks can be made from small-diameter, low-grade hardwoods using System 6, by gang ripping low-grade hardwood lumber, and with No. 2 Common and Better hardwood lumber (Araman and Hansen 1983, Gatchell et al. 1983, Reynolds and Gatchell 1982). Standard blank sizes, thickness, and quality specifications are shown in Table 1.

This paper is a step-by-step instruction manual on the use of the IBM-PC microcomputer to determine the quantity of blanks required to make a cutting bill of rough-dimension parts. Microcomputers with IBM-PC compatibility may be used. We present four computer programs:

CBMAKE: To record and sort the rough-dimension parts cutting bill data.

BLANKS: To calculate the blanks needed to make the rough-dimension parts from cutting bills (Araman 1983).

CBPRINT: To print the rough-dimension parts cutting bills from the permanent record.

CBIPRINT: To print the rough-dimension parts cutting bill permanent record index.

We suggest that the user of these instructions run the examples given in this paper. Using the same input and getting the same output will assure the user that the programs have been correctly entered and used.

We assume that the person using these programs has and is familiar with an IBM-PC with MS DOS 2.0 that includes the BASICA option. A 256K memory, two disk drives, and a matrix printer are also assumed. We do not include the normal PC operating instructions in this paper, just those instructions pertaining to the blanks programs.

Users of the programs should format a diskette using the /S option. Then copy the MSDOS diskette files onto this diskette. We use COMMAND.COM, ANSI.SYS, SYS.COM, PRINT.COM, ASSIGN.COM, FIND.EXE, and BASICA.COM. These files use 58K bytes of diskette space leaving 258K bytes of space available. The CBMAKE.BAS, CBPRINT.BAS, BLANKS.BAS, and CBIPRINT.BAS should then be entered into the computer and saved on this same diskette. A second diskette formatted without the /S option should be used in drive B to store the cutting bill files.

Table 1.—Hardwood blank standard sizes for furniture and cabinet manufacturers (inches)

Nominal thickness	Intended product finish thickness	Actual blank thickness	Blank length											
Clear Quality/26-Inch-Wide Blanks														
5/8	3/8	1/2	13	15	17	18	22	26	31	36	42			
3/4	1/2	5/8	14	17	19	22	25	29	31	35	41	47	58	86
1	3/4	7/8	15	18	21	25	29	33	38	45	50	60	75	100
1-1/4	1	1-1/8	15	18	21	25	29	33	38	45	50	60	75	100
1-1/2	1-1/4	1-3/8	15	18	21	25	28	32	35	40	45	50	60	70 85
2	1-5/8	1-3/4	15	18	21	25	28	32	35	40	45	50	60	70 90
Core Quality/26-Inch-Wide Blanks														
1	3/4	7/8	15	18	21	23	26	29	34	40	50	60	70	95
1-1/4	1	1-1/8	15	18	21	23	26	29	34	40	50	60	70	85
Sound Quality/20-Inch-Wide Blanks ^a														
1	3/4	7/8	13	17	19	22	24	27	29	33	44	54	70	80 100
1-1/4	1	1-1/8	15	18	20	23	25	28	33	45	55	65	80	90 100
1-1/2	1-1/4	1-3/8	14	18	21	24	28	31	34	40				
2	1-5/8	1-3/4	12	16	19	21	24	28	30	34				
Sound Quality/20-Inch-Wide Blanks ^b														
1	3/4	7/8	15	18	21	25	29	34	40	50	60	70	95	

^a For upholstery frames.

^b For case goods.

The Complete Rough-Dimension Parts Cutting Bill

Rough-dimension parts are pieces of solid or edge-glued wood used to make the fully machined parts needed for furniture assembly. Rough-dimension part sizes are normally specified by the nominal thickness of lumber from which they are cut, and by adding 1 inch to the finished part length and 1/4 to 1/2 inch to the finished part width. Consider that furniture company ABC Enterprises buys enough blanks from XYZ Corporation to make 100 dining room buffet cupboards. The cupboards consist of a top, No. 1317, and a base, No. 1315. The cutting bill for the No. 1317 top is shown in Table 2, and the cutting bill for the No. 1315 base is shown in Table 3. Since tops and bases are to be made at one time, we combined the two cutting bills.

Blanks are made in only one species, thickness, and quality at a time. Therefore, program BLANKS is set up to consider only one species, thickness, and quality of rough-dimension parts at a time. The first step is to subdivide the cutting bill. Red oak and yellow-poplar are the only two species used, as shown in the species column of Tables 2 and 3. Three red oak thicknesses (4/4, 5/4, and 6/4) are needed in clear grade. But only 4/4 yellow-poplar sound (interior) grade parts are needed. Altogether four program BLANKS runs are required. We demonstrate the 4/4 red oak run in step-by-step detail and include the results of the other three runs.

Table 2.—ABC Enterprises, Inc.—Bill of Materials for Buffet Top #1317

Quantity	Part Name	Rough size			Net size			Species
		Length	Width	Thickness	Length	Width	Thickness	
200	End Panel (2)	38	10-7/8	4/4	37	10-3/8		Red Oak
100	Top Front Brace (1)	38-1/4	2-1/4	4/4	37-1/4	2	13/16	Red Oak
100	Bottom Bandsawed Brace (1)	38-1/4	2-3/4	4/4	37-1/4	2-1/2	13/16	Red Oak
100	Top Back Brace (1)	39-1/2	1-3/4	4/4	38-1/2	1-1/2	13/16	Yellow-Poplar
100	Bottom Back Brace (1)	38-1/4	2-1/4	4/4	37-1/4	2	13/16	Red Oak
100	Top Shelf (1)	39	9-5/8	4/4	38	9-1/8	3/4	Red Oak
100	Center Shelf (1)	39	10-5/8	4/4	38	10-3/16	3/4	Red Oak
100	Front Upright (1)	23	2-1/8	4/4	22	1-5/8	13/16	Red Oak
100	End Foot (2)	23-5/8	2-1/4	4/4	11-1/4	2	13/16	Red Oak
100	Top Front Moulding (1)	43-1/4	3-3/4	6/4	41-3/4	3-1/2	1-1/4	Red Oak
200	Top End Moulding (2)	26	3-3/4	6/4	12	3-1/2	1-1/4	Red Oak
200	Door Header (2)	17	4-7/8	5/4	16	4-5/8	1	Red Oak
200	Door Rail (2)	17	2-3/8	5/4	16	2-1/8	1	Red Oak
400	Door Stile (4)	24-1/8	2-1/4	5/4	23-3/16	2	1	Red Oak
100	Horizontal Door Strip (1)	16	1-5/8	4/4	15	1/2	3/4	Red Oak
100	Vertical Door Strip (1)	18-1/8	1-5/8	4/4	17-3/16	1/2	3/4	Red Oak
50	Front Bead Moulding (1/2)	40-3/4	1-5/8	4/4	39-3/4	1/2	1/2	Red Oak
100	End Bead Moulding (1)	11-7/8	1-5/8	4/4	10-1/10	1/2	1/2	Red Oak

Table 3.—ABC Enterprises, Inc.—Bill of Materials for Buffet Base #1315

Quantity	Part Name	Rough size			Net size			Species
		Length	Width	Thickness	Length	Width	Thickness	
100	Top (1)	43	18-1/2	4/4	42	18	3/4	Red Oak
200	End Panel (2)	33	16-7/8	4/4	32	16-3/8	3/4	Red Oak
100	Top Front Brace (1)	37-7/8	1-3/4	4/4	36-7/8	1-7/16	3/4	Red Oak
100	Center Front Brace (1)	39-7/8	2-1/4	4/4	38-7/8	2	13/16	Red Oak
100	Bottom Front Brace (1)	39-7/8	2-1/4	4/4	38-7/8	2	13/16	Red Oak
100	Top Back Brace (1)	39-7/8	2-1/4	4/4	38-7/8	2	13/16	Yellow-Poplar
100	Center Back Brace (1)	39-7/8	2-1/4	4/4	38-7/8	2	13/16	Yellow-Poplar
100	Bottom Back Brace (1)	39-7/8	2-1/4	4/4	38-7/8	2	13/16	Yellow-Poplar
200	End Upright (2)	33	2-1/4	4/4	32	2	3/4	Red Oak
100	Bottom Upright (1)	21-3/8	1-3/4	4/4	20-3/8	1-1/2	13/16	Red Oak
100	Front Foot (1)	42-3/8	5-1/8	4/4	41-3/8	4-7/8	3/4	Red Oak
200	End Foot (2)	17-3/4	5-1/8	4/4	16-3/4	4-7/8	3/4	Red Oak
100	Shelf (1)	39-3/4	8-1/2	4/4	38-3/4	8	11/16	Yellow-Poplar
100	Drawer Front (1)	37-1/2	5-1/8	4/4	36-1/2	4-7/8	3/4	Red Oak
200	Drawer Guide (2)	14-3/4	2-3/8	4/4	13-3/4	2-1/8	1/2	Yellow-Poplar
200	Drawer Guide (2)	16-7/8	1-1/4	4/4	15-7/8	1	1/2	Yellow-Poplar
100	Door Lipped Stile (1)	21-3/8	3-1/8	4/4	20-3/8	2-7/8	13/16	Red Oak
500	Door Stile (5)	21-3/8	2-1/4	4/4	20-3/8	2	13/16	Red Oak
300	Door Header (3)	10-3/8	3-7/8	4/4	9-3/8	3-5/8	13/16	Red Oak
300	Door Rail (3)	10-3/8	2-1/4	4/4	9-3/8	2	13/16	Red Oak
300	Door Panel (3)	17-3/8	9-1/4	4/4	16-3/8	8-3/4	9/16	Red Oak

The 4/4 C1F Red Oak Parts Cutting Bill: Program CBMAKE

The 4/4 red oak parts data must be arranged in a specific way to be used as input for the BLANKS program. The parts data cannot be fed directly into program BLANKS. The parts data must be entered as requested by the CBMAKE program. When the data input is complete, the CBMAKE program will perform the necessary sorting and control data calculations. The sorted data are saved and can be used as input to program BLANKS.

With the program diskette in drive A, bring up BASICA and then the CBMAKE program using LOAD "A:CBMAKE.BAS" (Appendix I). The second formatted diskette must be put in drive B. This diskette will be used to store cutting bill data and should be labeled accordingly. Two hundred part sizes are the maximum number allowed. The dimension statements in CBMAKE (lines 10 to 120) and in BLANKS (lines 60 to 100) must be changed if more than 200 part sizes are needed.

The first prompt will ask if a new cutting bill is to be started, or if the cutting bill in the CBX file is to be added to or to be corrected. CBX is a temporary file to hold unsorted data. We follow the program through the "new cutting bill" option and then through the "add and correct" option as shown in Figure 1. Enter 1 to this prompt to create a new cutting bill. When starting a new cutting bill the previous cutting bill in the temporary (CBX) file will be erased. When you start a cutting bill, complete the entire data entry—addition, correction, and sorting sequence—before starting another new cutting bill.

The first program prompt asks for "our" order number, which is the blank maker's order number. Now the prompt asks for the buyer's (customers) company name and address. The next prompt asks for the buyer's order number. We have assumed that the blank maker will be selling blanks but a maker using his blanks will use CBMAKE in the same way. Finally, the prompt asks for the cutting bill file number. In this example, we use our order number 999999. The ABC Enterprises, Inc., at 345 Wistfull Vista, Gastonia, NC 28052 is the buyer. Their order number is 987987. The cutting bill number assigned is CB1.

Following this last entry, the heading data entered are stored in diskette B under the "B:CBINDEX.DAT" label. When using a new diskette to store the cutting bill data, statement 360 will cause an error condition. Temporarily, change statement 360 to read OPEN "B:CBINDEX.DAT" for OUTPUT as #1. With the statement in this form, the CB index file will be opened. Normally, statement 360 reads OPEN "B:CBINDEX.DAT" for APPEND as #1, and the additional cutting bill heading data will be added to the CBINDEX file.

By using program CBIPRINT (Appendix IV), the CBINDEX file (the list of cutting bills stored on the cutting bill diskette) can be read. Use LOAD "A:CBIPRINT.BAS" and hit F2 to print the CBINDEX file.

Now the program prompts call for the parts data. The 4/4 red oak parts data in Tables 2 and 3 are used. The line number is entered. Then the parts length is entered. The blank length used to make this part, as found in Table 1, is entered next. If the parts length is 1/2 inch or less longer than the closest blank length, then enter the parts length as the blank length. Rough part sizes are generally made 1 inch longer than finished part sizes. But, with parts being made from blanks, a 1/2 inch length allowance on the rough part is sufficient.

When the last cutting data have been entered or if you want to stop entering data for any reason, enter 999 instead of the next line number. The data are listed on the screen 10 data lines at a time.

Following the listing of all the data lines, the number of cuttings (same as data lines) is given. A prompt follows asking for the correct number of cuttings. Under certain circumstances, this number of cuttings could change and require correction. Now the cutting data can be printed if required. Line corrections can be made at this time. The data as shown are saved in the CBX file.

To add to this data or to correct this data, run the program again. Now enter 2 for the first prompt. The data stored in the CBX file are read. The program proceeds in the same fashion as before. The last line of the data in the CBX file is shown so that the additional data entry line numbers can be started from that line. The customer name, and so on, need not be re-entered as this was read from the CBX file.

The unsorted data are temporarily stored on the B drive diskette as file CBX.DAT as shown in Figure 2. **Remember**, the next time CBMAKE is used to make a new set of data, the new data will be stored in the CBX file and the previous data will be lost. Therefore, you should continue with the sorting program before entering a new cutting bill.

The sorting and control data determinations will now proceed. Since this is a simple bubble sort routine, the process is slow. Messages showing the progress appear on the screen. After sorting is complete, the sorted data appear on the screen 10 lines at a time. The sorted data can then be printed as shown in Figure 3.

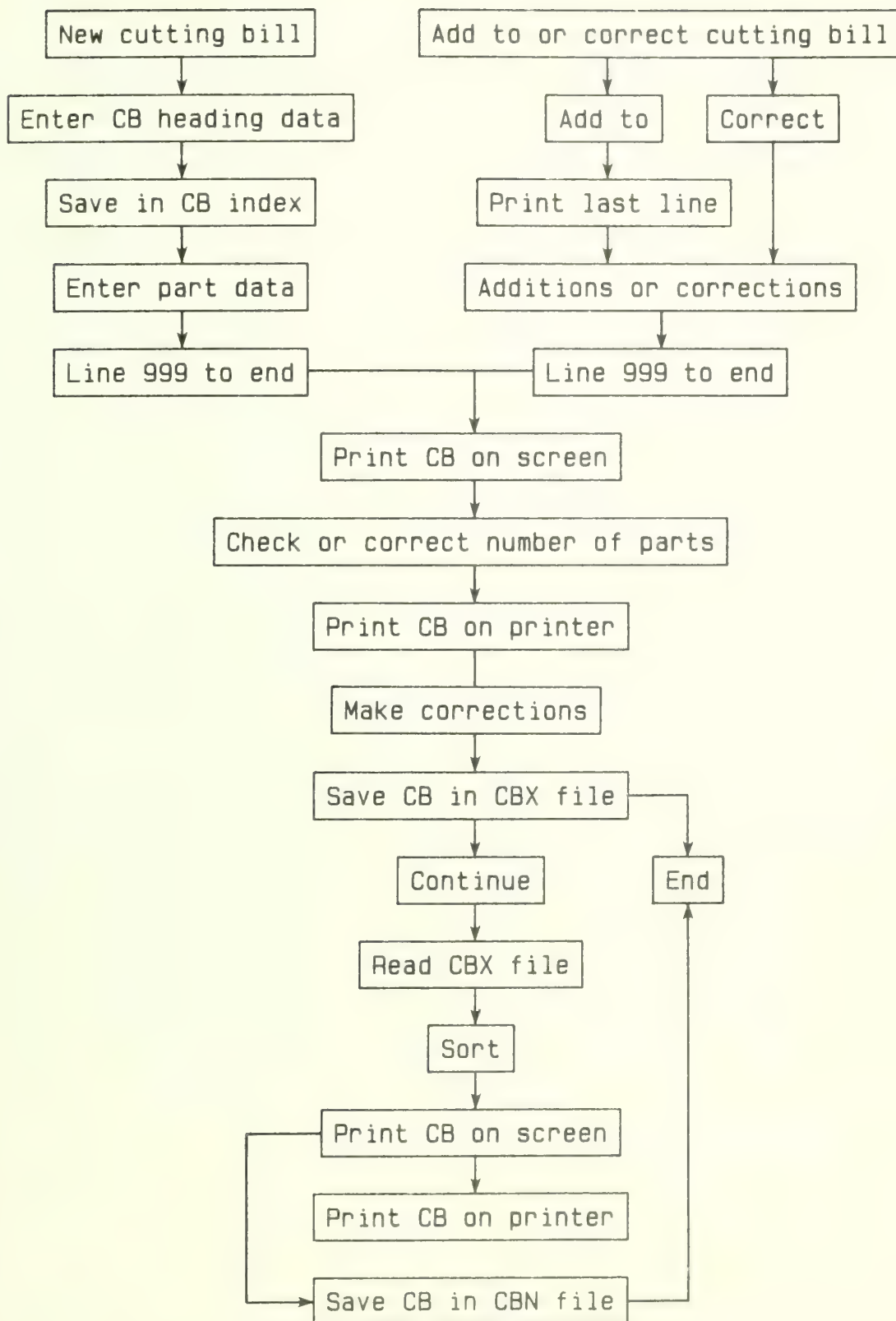


Figure 1.—Program CBMAKE flowchart.

B L A N K S B Y X Y Z C O R P O R A T I O N

Date 01-14-1985

Order No. 999999

Customer Name: ABC Enterprises
 Street: 345 Wistfull Vista
 City: Gastonia NC 28052

Order No. 987987
 CB Number: CB1

Blank Specifications: Red Oak

4/4 C1F Standard

Line No.	Blank Length (in)	Part Length (in)	Part Width (in)	Part Quantity (number)	Case Number	Part Name
1	38.000	38.000	10.875	200	1317	End panel
2	38.000	38.000	2.250	100	1317	Top front brace
3	38.000	38.000	2.750	100	1317	Bottom bandsawed brace
4	38.000	38.000	2.250	100	1317	Bottom back brace
5	45.000	39.000	9.625	100	1317	Top shelf
6	45.000	39.000	10.625	100	1317	Center shelf
7	25.000	23.000	2.125	100	1317	Front upright
8	25.000	23.625	2.250	200	1317	End foot
9	18.000	16.000	1.625	100	1317	Horizontal door strip
10	18.000	18.000	1.625	100	1317	Vertical door strip
11	45.000	40.750	1.625	50	1317	Front door moulding
12	15.000	11.875	1.625	100	1317	End bead moulding
13	45.000	43.000	18.500	100	1315	Top
14	33.000	33.000	16.875	200	1315	End panel
15	38.000	37.875	1.750	100	1315	Top front brace
16	45.000	39.875	2.250	100	1315	Center front brace
17	45.000	39.875	2.250	100	1315	Bottom front brace
18	33.000	33.000	2.250	200	1315	End upright
19	25.000	21.375	1.750	100	1315	Bottom upright
20	45.000	42.375	5.125	100	1315	Front foot
21	18.000	17.750	5.125	200	1315	End foot
22	38.000	37.500	5.125	100	1315	Drawer front
23	25.000	21.375	3.125	100	1315	P. door lipped stile
24	25.000	21.375	2.250	500	1315	P. door stile
25	15.000	10.375	3.875	300	1315	P. door header
26	15.000	10.375	2.250	300	1315	P. door rail
27	18.000	17.375	9.250	300	1315	P. door panel

Number of Different Blank Lengths 0

Line No. Blank Length Start

Line no. Blank Length End

Figure 2.—4/4 C1F red oak cutting bill—unsorted.

B L A N K S B Y X Y Z C O R P O R A T I O N

Date 01-14-1985

Order No. 999999

Customer Name: ABC Enterprises
 Street: 345 Wistfull Vista
 City: Gastonia NC 28052

Order No. 987987
 CB Number: CB1

Blank Specifications: Red Oak

4/4 C1F Standard

Line No.	Blank Length (in)	Part Length (in)	Part Width (in)	Part Quantity (number)	Case Number	Part Name
1	15.000	10.375	3.875	300	1315	P. door header
2	15.000	10.375	2.250	300	1315	P. door rail
3	15.000	11.875	1.625	100	1317	End bead moulding
4	18.000	17.375	9.250	300	1315	P. door panel
5	18.000	17.750	5.125	200	1315	End foot
6	18.000	16.000	1.625	100	1317	Horizontal door strip
7	18.000	18.000	1.625	100	1317	Vertical door strip
8	25.000	21.375	3.125	100	1315	P. door lipped stile
9	25.000	23.625	2.250	200	1317	End foot
10	25.000	21.375	2.250	500	1315	P. door stile
11	25.000	23.000	2.125	100	1317	Front upright
12	25.000	21.375	1.750	100	1315	Bottom upright
13	33.000	33.000	16.875	200	1315	End panel
14	33.000	33.000	2.250	200	1315	End upright
15	38.000	38.000	10.875	200	1317	End panel
16	38.000	37.500	5.125	100	1315	Drawer front
17	38.000	38.000	2.750	100	1317	Bottom bandsawed brace
18	38.000	38.000	2.250	100	1317	Top front brace
19	38.000	38.000	2.250	100	1317	Bottom back brace
20	38.000	37.875	1.750	100	1315	Top front brace
21	45.000	43.000	18.500	100	1315	Top
22	45.000	39.000	10.625	100	1317	Center shelf
23	45.000	39.000	9.625	100	1317	Top shelf
24	45.000	42.375	5.125	100	1315	Front foot
25	45.000	39.875	2.250	100	1315	Center front brace
26	45.000	39.875	2.250	100	1315	Bottom front brace
27	45.000	40.750	1.625	50	1317	Front door moulding

Number of Different Blank Lengths 6

Line No. Blank Length Start

Line no. Blank Length End

1

3

4

7

8

12

13

14

15

20

21

27

Figure 3.—4/4 C1F red oak cutting bill—sorted.

The sorted data, complete with header and index control data, are stored in the drive B diskette. It is stored under the cutting bill number as given in the first part of the CBMAKE program use. If the cutting bill number used is the same as a cutting bill number previously used, the previous data will be erased. The sorted data will be used to run the BLANKS program and therefore *must be saved*.

The completed cutting bills can be shown on the screen and printed from the B drive diskette using program CBPRINT (Appendix III). Use LOAD "A:CBPRINT.BAS" and then enter the correct cutting bill by following the prompts. Hit F2 to print the selected cutting bill.

The 4/4 C1F red oak rough-dimension parts cutting bill is now completed and is stored as CB1. Other rough-dimension parts cutting bills can now be entered, corrected, sorted, and saved. The CB1 rough-dimension parts can be run through program BLANKS at any time.

The 4/4 C1F Red Oak Blanks Cutting Bill: Program BLANKS

The sorted parts data are fed into program BLANKS. The blanks necessary to make the required parts are calculated one blank length at a time. Then the total blank quantity in all lengths is found.

With the sorted cutting bill complete with index controls stored in the B drive diskette, program BLANKS can be run. With the program diskette in drive A and the cutting bill data diskette in drive B, bring up BASICA. Then use LOAD "A:BLANKS.BAS" to bring up program BLANKS (Appendix II). Hit key F2 to start the program. The prompt will ask for the cutting bill number. For this example, enter CB1.

The next set of program prompts calls for the blanks width and blanks price data. For the first prompt in this example, 15-inch blanks data are requested, a 26-inch-width, followed by a comma, and a \$1 price are entered. The blank widths are taken from Table 1. The blanks prices are arbitrarily set in this paper. A discussion of blanks price allocation is beyond the scope of this paper. For this example, we have assumed values of \$1 per square foot for 15-inch blanks, \$1.50 per square foot for 18-inch blanks, and \$2 per square foot for all other blanks. A prompt for each blank length will appear.

Now a statement appears stating that the program is being run. The program will be controlled by line control values on the rough-dimension parts cutting bill (Fig. 3). Do not be impatient. The 27-line cutting bill used in this example takes about 20 seconds to run.

The results showing blank size, blank quality, blank and parts footage, and yield and blanks price will appear. The heading data were read from the cutting bill data file. Hitting F5, as prompted shows the remainder of the data. Then a prompt appears asking if a printed copy of the results is needed. Such a copy is shown in Figure 4. Entering 2 to this prompt erases these results and a new run can be made. After a printed copy has been made hit F2 to start another run.

A 1/8-inch saw kerf is added to the parts width for ripping the parts from blanks. If another saw kerf is to be used, statements 560, 580, 700, 830, 900, 1080, and 1130 must be changed. The values of 0.125 must be changed to the new kerf value.

The sorted cutting bill (Fig. 3) and the BLANKS output (Fig. 4) should be made available to the people ripping the parts from the blanks. They will follow the part width specification in the order given in the sorted cutting bill. For example, when ripping the 81 blanks 1 1/2 inches long to the 700 parts, they will first rip the 3.875-inch-wide parts. There will be six pieces made from each blank, and 50 blanks will be used to make the 300 parts. The 2-inch-wide remainder from each blank will be made to one 1.625-inch-wide piece for a total of 50 pieces. Then the 2.25-inch parts will be ripped from 27 blanks without any remainder. These blanks yield 11 parts per blank, for a total of 297 parts. One blank is used to make the last three parts 2.25 inches wide. The 18.875-inch remainder is ripped to 10 parts 1.625 inches wide. Three blanks are ripped to 40 parts 1.625 inches wide with a 5-inch remainder from the last blank. This piece can be reglued for future use.

Completing the Parts and Blanks Cutting Bills

In addition to the 4/4 C1F red oak parts, there are 5/4 and 6/4 C1F red oak parts; and 4/4 sound (interior) yellow-poplar parts required to make the 1317 top and 1315 base. The reader should run programs CBMAKE and BLANKS for these parts. The same techniques used to determine the 4/4 C1F red oak parts cutting bill and blank requirements should be used for the other three cutting bills.

B L A N K S B Y X Y Z C O R P O R A T I O N

Date 01-14-1985

Order No. 999999

Customer: Name: ABC Enterprises
 Street: 345 Wistfull Vista
 City: Gastonia NC 28052

Order No. 987987
 CB Number: CB1

Blank Specifications: Red Oak

4/4 C1F Standard

Blank Size (inches)	Blanks (number)	Blanks (sqft)	Parts (sqft)	Yield (%)	Price (dollars)	Price (\$/sqft)
15.000x26	81	219	146	66.46	219.38	1.00
18.000x26	165	536	500	93.16	804.38	1.50
25.000x26	93	420	347	82.69	839.58	2.00
33.000x26	200	1,192	877	73.56	2,383.33	2.00
38.000x26	147	1,009	945	93.67	2,017.17	2.00
45.000x26	205	1,666	1,399	84.01	3,331.25	2.00
Totals	891	5,041	4,213	83.57	9,595.08	

Blank Size (inches)	Reglue (%)	Reglue Value(\$)	End Waste (%)	Edge Waste (%)	Total Waste(%)
15.000x26	0.46	1.02	28.51	4.57	33.08
18.000x26	0.91	7.36	3.00	2.93	5.93
25.000x26	0.98	8.19	11.40	4.94	16.33
33.000x26	23.08	550.00	0.00	3.37	3.37
38.000x26	3.73	75.14	0.19	2.41	2.60
45.000x26	5.03	167.54	8.27	2.69	10.96
Totals	8.06	809.25	5.28	3.09	8.37

Figure 4.—4/4 C1F red oak blanks.

The 5/4 C1F red oak parts cutting bill (all for the 317 top, Table 2) is shown in Figure 5 as cutting bill 2. The 5/4 C1F red oak blank prices were found by increasing the 4/4 C1F red oak blank prices by 25 per-

cent as 5/4 blanks require 25 percent more board footage than 4/4 blanks. The 5/4 C1F red oak blanks required to make the cutting bill 2 parts are shown in Figure 6.

B L A N K S B Y X Y Z C O R P O R A T I O N

Date 01-14-1985

Order No. 999999

Customer Name: ABC Enterprises Inc
 Street: 345 Wistfull Vista
 City: Gastonia NC 28052

Order No. 987987
 CB Number: CB2

Blank Specifications: Red Oak

C1F 5/4 Standard

Line No.	Blank Length (in)	Part Length (in)	Part Width (in)	Part Quantity (number)	Case Number	Part Name
1	18.000	17.000	4.875	200	1317	G. door header
2	18.000	17.000	2.375	200	1317	G. door rail
3	25.000	24.125	2.250	400	1317	G. door stile

Number of Different Blank Lengths 2

Line No.	Blank Length	Start	Line no.	Blank Length	End
		1			2
		3			3

1
3

2
3

Figure 5.—5/4 C1F red oak cutting bill—sorted.

B L A N K S B Y X Y Z C O R P O R A T I O N

Date 01-14-1985

Order No. 999999

CUSTOMER: Name: ABC Enterprises Inc
 Street: 345 Wistfull Vista
 City: Gastonia NC 28052

Order No. 987987
 CB Number: CB2

Blank Specifications: Red Oak

C1F 5/4 Standard

Blank Size (inches)	Blanks (number)	Blanks (sqft)	Parts (sqft)	Yield (%)	Price (dollars)	Price (\$/sqft)
18.000x26	60	195	171	87.78	366.60	1.88
25.000x26	37	167	151	90.28	417.53	2.50
Totals	97	362	322	88.94	784.13	

Blank Size (inches)	Reglue (%)	Reglue Value(\$)	End Waste (%)	Edge Waste (%)	Total Waste(%)
18.000x26	3.85	14.10	5.16	3.21	8.37
25.000x26	1.72	7.18	3.27	4.73	8.00
Totals	2.87	21.28	4.29	3.91	8.20

Figure 6.—5/4 C1F red oak blanks.

increasing the 4/4 C1F red oak blank prices by 50 percent. The 6/4 C1F red oak blanks required to make the cutting bill 3 parts are shown in Figure 8.

Order No. 999999

Order No. 987987
CB Number: CB3

C1F 6/4 Standard

Number of Different Blank Lengths			2
Line No.	Blank Length	Start	Line no. Blank Length End
		1	
		2	

Order No. 999999

Order No. 987987
CB Number: CB3

C1F 6/4 Standard

Blank Size (inches)	Reglue (%)	Reglue Value(\$)	End Waste (%)	Edge Waste (%)	Total Waste(%)
29.000x26	12.33	65.85	8.78	2.83	11.60
45.000x26	12.33	51.09	3.30	2.83	6.13
Totals	12.33	116.95	6.38	2.83	9.21

11

There were 4/4 yellow-poplar parts of sound (interior) grade needed for both furniture pieces as shown in Tables 2 and 3. The cutting bill for these parts is shown in Figure 9 as cutting bill 4. The 4/4 sound (interior) yellow-poplar blank prices were estimated by considering the differences in red oak and yellow-poplar lumber prices. The 4/4 sound (interior)

yellow-poplar blanks required to make the cutting bill 4 parts are shown in Figure 10.

The complete list of blanks needed to make 100 sets of china hutch base and tops is shown in Table 4. These data were compiled manually from Figures 4, 6, 8, and 10.

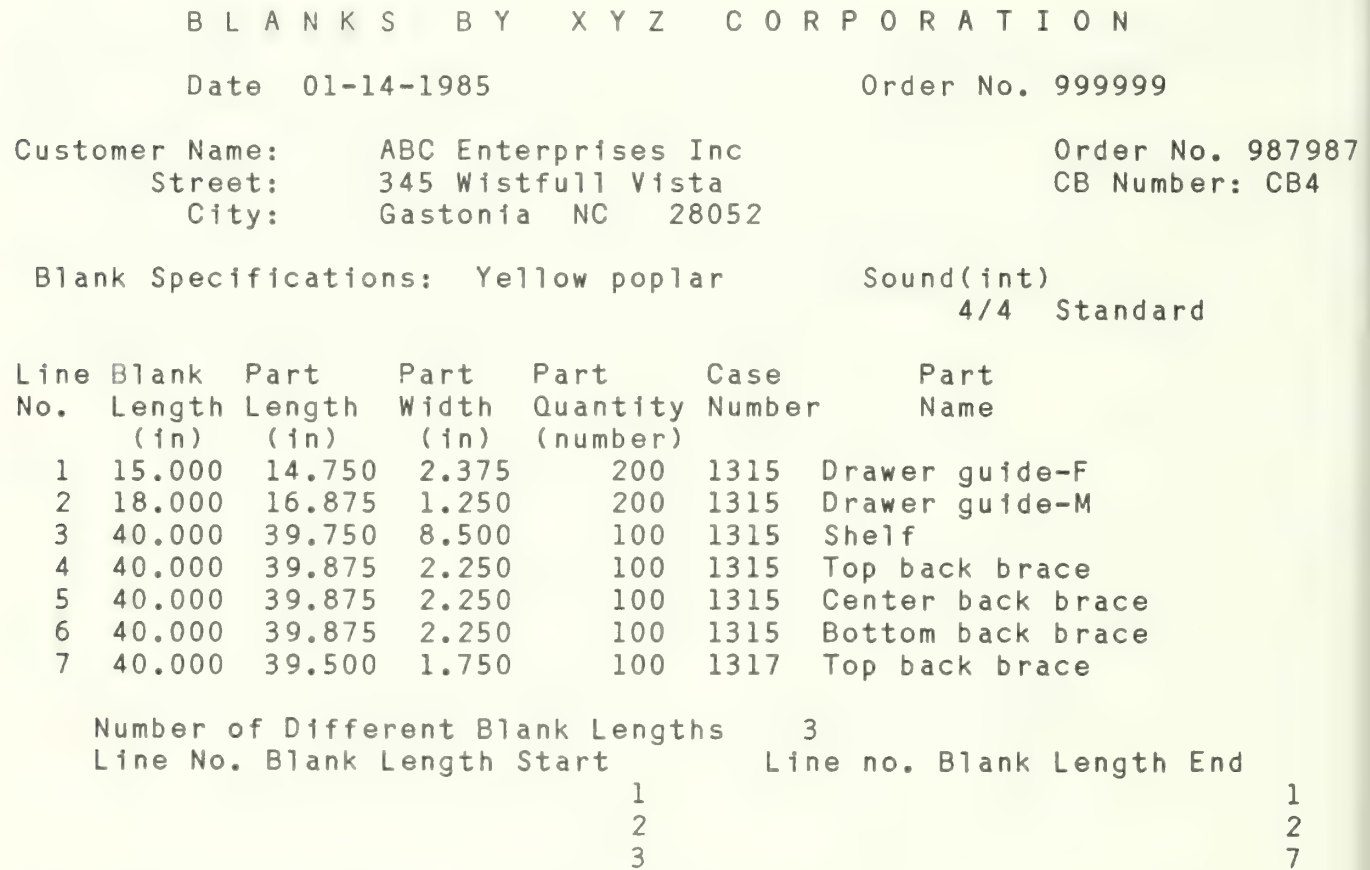


Figure 9.—4/4 sound (int.) yellow-poplar cutting bill—sorted.

B L A N K S B Y X Y Z C O R P O R A T I O N

Date 01-14-1985

Order No. 999999

Customer: Name: ABC Enterprises Inc
 Street: 345 Wistfull Vista
 City: Gastonia NC 28052

Order No. 987987
 CB Number: CB4

Blank Specifications: Yellow poplar

Sound(int)
 4/4 Standard

Blank Size (inches)	Blanks (number)	Blanks (sqft)	Parts (sqft)	Yield (%)	Price (dollars)	Price (\$/sqft)
15.000x20	25	52	49	93.42	39.06	0.75
18.000x20	15	38	29	78.13	37.50	1.00
40.000x20	92	511	470	91.87	638.89	1.25
Totals	132	601	548	91.15	715.45	

Blank Size (inches)	Reglue (%)	Reglue Value(\$)	End Waste (%)	Edge Waste (%)	Total Waste(%)
15.000x20	0.00	0.00	1.58	5.00	6.58
18.000x20	4.76	1.79	5.21	11.90	17.11
40.000x20	3.14	20.05	0.52	4.47	4.99
Totals	2.97	21.84	0.91	4.98	5.89

Figure 10.—4/4 sound (int.) yellow-poplar blanks.

Table 4.—Blanks to rough-dimension parts
(Blanks needed to make 100 sets of 1315 base and 1317 top)

Length (in)	Red oak clear 26" width			Length (in)	Yellow-poplar soud (int.) 20" width
	4/4	5/4	6/4		
BLANK QUANTITIES					
15	81	*	*	15	25
18	165	60	*	18	15
21	*	*	*	21	*
25	93	37	*	25	*
29	*	*	34	29	*
33	200	*	*	34	*
38	147	*	*	40	92
45	205	*	17		
Total	891	97	51		132
BLANK PRICES (\$/ft²)					
15	1.00	*	*	15	0.75
18	1.50	1.88	*	18	1.00
21	*	*	*	21	*
25	2.00	2.50	*	25	*
29	*	*	3.00	29	*
33	2.00	*	*	34	*
38	2.00	*	*	40	1.25
45	2.00	*	3.00		

* No blanks required.

1,171 blanks required to make the 5,450 parts needed.

6,320 ft² of blanks to make 5,331 ft² parts 84.4% yield
plus 474 ft² reglue 7.5% yield

91.9% yield

\$12,079.13 blanks to \$11,145.07 parts + \$934.06 reglue = \$2.09/ft² parts + reglue

\$12,079.13 blanks to \$12,079.13 parts + \$0.0 reglue = \$2.27/ft² parts

\$2.09/ft² parts = \$111/base and top set - blanks cost

\$2.27/ft² parts = \$121/base and top set - blanks cost

Literature Cited

Araman, Philip A. **BLANKS: A computer program for analyzing furniture rough-part needs in standard-size blanks.** Res. Pap. NE-521. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 8 p.

Araman, Philip A.; Gatchell, Charles J.; Reynolds, Hugh W. **Meeting the solid wood needs of the furniture and cabinet industries: standard-size hardwood blanks.** Res. Pap. NE-494. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982. 7 p.

Araman, Philip A.; Hansen, Bruce G. **Conventional processing of standard-size edge-glued blanks for**

furniture and cabinet parts—a feasibility study. Res. Pap. NE-524. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.

Gatchell, Charles J.; Anderson, R. Bruce; Araman, Philip A. **Effect of gang ripping width on C1F yields from No. 2 Common oak lumber.** Forest Products J. 33(6): 43-48; 1983.

Reynolds, Hugh W.; Gatchell, Charles J. **New technology for low grade hardwood utilization: System 6.** Res. Pap. NE-504. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982. 8 p.

APPENDIX I: Program CBMAKE

```
10 REM This program is used to make and sort cutting bill (CB) files
20 REM This program is saved as "A:CBMAKE.BAS"; written in BASICA
30 REM The cutting bill data is saved in two files on drive B:
40 REM The cutting bill heading data is stored in "B:CBINDEX.DAT".
50 REM The unsorted cutting bill heading & parts data is temporarily stored in B
:CBX.DAT".
60 REM (1) Unsorted data is sorted by blank length (ascending).
70 REM (2) Program Blanks iteration control values are found.
80 REM (3) The data is sorted by cutting width per blank length (descending).
90 REM The sorted cutting bill heading & parts data is stored in "B:CBn.DAT"
100 REM There can be 999,999 cutting bill files, ie, "B:CB999999.DAT" is max.
110 DIM PL(200),PW(200),PQ(200),CA(200),PN$(200),BL(200),LN(200),ITS(25),ITE(25)

120 DIM SPL(200),SPW(200),SPQ(200),SCA(200),SPN$(200),SBL(200),SLN(200)
130 OD1$="###.###.###.###.###.###.###.###.###.### \
\
"
140 NC=0: X2=0
150 CLS
160 INPUT "Enter 1 for new cutting bill. 2 to add to or correct cutting bill in
CBX file";X3
170 IF X3=1 THEN 300 ELSE 180
180 OPEN "B:CBX.DAT" FOR INPUT AS #1
190 INPUT #1, BMO$,BBN$,BBS$,BBC$,BBST$,BBZ$,BBO$,S$,Q$,TH$,STD$,CBN$,D$,NC
200 FOR I=1 TO NC STEP 1
210 INPUT #1, I,PL(I),BL(I),PW(I),PQ(I),CA(I),PN$(I)
220 NEXT I
230 CLOSE #1
240 INPUT "Enter 1 to add to cutting bill. 2 for corrections";X4
250 IF X4=1 THEN 260 ELSE 390
260 PRINT "This is the last line in the cutting bill file"
270 II=NC
280 PRINT USING OD1$;II;PL(II);BL(II);PW(II);PQ(II);CA(II);PN$(II)
290 GOTO 390
300 INPUT "Enter Our Order Number. Date will enter automatically";BMO$
310 INPUT "Enter blank buyer's name, street address, city, state, zip code";BBN$,
BBS$,BBC$,BBST$,BBZ$
320 INPUT "Enter blank buyer's order no. ";BBO$
330 INPUT "Blank Species, Quality, Thickness, Standard or Non-Standard";S$,Q$,TH
$,STD$
340 D$=DATE$
350 INPUT "Enter Cutting Bill File Number. CBnnnnnn six digits maximum";CBN$
360 OPEN "B:CBINDEX.DAT" FOR APPEND AS #1
370 WRITE #1, BMO$,BBN$,BBS$,BBC$,BBST$,BBZ$,BBO$,S$,Q$,TH$,STD$,CBN$,D$,NC
380 CLOSE #1
390 PRINT "Enter Part Data"
400 INPUT "Enter line number. Enter 999 to end data entry"; I
410 IF I=999 THEN 470 ELSE 420
420 INPUT "Enter Part Length, Blank Length, Width, Quantity, Case, Name";PL(I),
BL(I),PW(I),PQ(I),CA(I),PN$(I)
430 LN(I)=I
440 IF X2=1 THEN 400 ELSE 450
450 NC=NC+1
460 GOTO 400
470 GOSUB 1290
480 PRINT "The number of different cuttings in this bill=";
490 PRINT TAB(55) NC
500 INPUT "Enter the correct number of different cuttings"; NC
```



```

0 PRINT "Second sort iteration"
0 K1=ITE(J)-ITS(J)
1 IF K1=0 THEN 1130 ELSE 1030
0 I=ITS(J)
0 FOR K=1 TO K1 STEP 1
0 IF PW(I+1)>PW(I) THEN 1060 ELSE 1090
0 SPL=PL(I+1): SBL=BL(I+1): SPW=PW(I+1): SPQ=PQ(I+1): SCA=CA(I+1): SPN$=PN$(I
0 PL(I+1)=PL(I): BL(I+1)=BL(I): PW(I+1)=PW(I): PQ(I+1)=PQ(I): CA(I+1)=CA(I):
(I+1)=PN$(I)
0 PL(I)=SPL: BL(I)=SBL: PW(I)=SPW: PQ(I)=SPQ: CA(I)=SCA: PN$(I)=SPN$
0 I=I+1
0 NEXT K
0 K1=K1-1: I=ITS(J)
0 IF K1=0 THEN 1130 ELSE 1040
0 NEXT J
0 GOSUB 1290
0 INPUT "Enter 1 to print a hard copy & save cutting bill. 2 to save only";X1
0 IF X1=1 THEN 1170 ELSE 1180
0 GOSUB 1770
0 OPEN "0",#1,CBNA$
0 WRITE #1,BM0$,BBN$,BBS$,BBC$,BBST$,BBZ$,BBO$,S$,Q$,TH$,STD$,CBN$,D$,NC
0 FOR I=1 TO NC STEP 1
0 WRITE #1,PL(I),BL(I),PW(I),PQ(I),CA(I),PN$(I)
0 NEXT I
0 PRINT #1, ITT
0 FOR I=1 TO ITT STEP 1
0 WRITE #1, ITS(I),ITE(I)
0 NEXT I
0 CLOSE #1
0 END
0 CLS
0 PRINT TAB(10) CHR$(14); "BLANKS BY XYZ CORPORATION"
0 PRINT
0 PRINT TAB(10) "Date";
0 PRINT TAB(16) D$;
0 PRINT TAB(45) "Order No.";
0 PRINT TAB(55) BM0$
0 PRINT
0 PRINT "Customer Name:";
0 PRINT TAB(20) BBN$;
0 PRINT TAB(55) "Order No.";
0 PRINT TAB(65) BBO$
0 PRINT TAB(8) "Street:";
0 PRINT TAB(20) BBS$;
0 PRINT TAB(55) "CB Number:";
0 PRINT TAB(66) CBN$
0 PRINT TAB(10) "City:";
0 PRINT TAB(20) BBC$;
0 PRINT TAB(30) BBST$;
0 PRINT TAB(35) BBZ$
0 PRINT
0 PRINT " Blank Specifications:";

```

```

1510 PRINT TAB(25) S$;
1520 PRINT TAB(45) Q$;
1530 PRINT TAB(55) TH$;
1540 PRINT TAB(60) STD$
1550 PRINT
1560 PRINT "Line Blank Part Part Part Case Part"
1570 PRINT "No. Length Length Width Quantity Number Name"
1580 PRINT " (in) (in) (in) (number)"
1590 FOR I=1 TO NC STEP 1
1600 PRINT USING OD1$;I;BL(I);PL(I);PW(I);PQ(I);CA(I);PN$(I)
1610 X7=X7+1
1620 IF X7=10 THEN 1630 ELSE 1660
1630 PRINT "Hit F5 to continue"
1640 STOP
1650 X7=0
1660 NEXT I
1670 PRINT
1680 PRINT TAB(5) "Number of Different Blank Lengths";
1690 PRINT TAB(41) ITT
1700 FOR I=1 TO ITT STEP 1
1710 PRINT TAB(5) "Line No. Blank Length Start";
1720 PRINT TAB(32) ITS(I);
1730 PRINT TAB(40) "Line no. Blank Length End";
1740 PRINT TAB(66) ITE(I)
1750 NEXT I
1760 RETURN
1770 LPRINT: LPRINT: LPRINT
1780 LPRINT TAB(10) CHR$(14);"BLANKS BY XYZ CORPORATION"
1790 LPRINT
1800 LPRINT TAB(10) "Date";
1810 LPRINT TAB(16) D$;
1820 LPRINT TAB(45) "Order No.";
1830 LPRINT TAB(55) BM0$
1840 LPRINT
1850 LPRINT "Customer Name:";
1860 LPRINT TAB(20) BBN$;
1870 LPRINT TAB(55) "Order No.";
1880 LPRINT TAB(65) BB0$
1890 LPRINT TAB(8) "Street:";
1900 LPRINT TAB(20) BBS$;
1910 LPRINT TAB(55) "CB Number:";
1920 LPRINT TAB(66) CBN$
1930 LPRINT TAB(10) "City:";
1940 LPRINT TAB(20) BBC$;
1950 LPRINT TAB(30) BBST$;
1960 LPRINT TAB(35) BBZ$
1970 LPRINT
1980 LPRINT " Blank Specifications:";
1990 LPRINT TAB(25) S$;
2000 LPRINT TAB(45) Q$;

```

```

10 LPRINT TAB(50) TH$;
20 LPRINT TAB(55) STD$
30 LPRINT
40 LPRINT "Line Blank Part Part Part Case Part"
50 LPRINT "No. Length Length Width Quantity Number Name"
60 LPRINT " (in) (in) (in) (number)"
70 FOR I=1 TO NC STEP 1
80 LPRINT USING OD1$;I;BL(I);PL(I);PW(I);PQ(I);CA(I);PN$(I)
90 NEXT I
00 LPRINT
10 LPRINT TAB(5) "Number of Different Blank Lengths";
20 LPRINT TAB(41) ITT
30 LPRINT TAB(5) "Line No. Blank Length Start";
40 LPRINT TAB(40) "Line no. Blank Length End"
50 FOR I=1 TO ITT STEP 1
60 LPRINT TAB(32) ITS(I);
70 LPRINT TAB(66) ITE(I)
80 NEXT I
90 LPRINT CHR$(12)
00 RETURN

```

APPENDIX II: Program BLANKS

```
10 REM This program is the translation of Araman's Program Blanks for the
20 REM IBM PC. See Report FS-NE-521 "Blanks: A Computer Program...".
30 REM This program is written in BASICA and is saved as A:BLANKS.BAS.
40 DEFINT N,L
50 DEFDBL W,S,B,U
60 DIM BL(200)
70 DIM NN(200), BBLANK(50), NNE(200), WLT(200), WT(200), SBLT(50), SBWT(50)
80 DIM BLT(50), ITS(13), ITE(13), BPRICEX(13), BWTX(13)
90 DIM SBSQFT(50), SCSQFT(50), SUTILP(50), STCOST(50), SREGP(50)
100 DIM SRGVAL(50), SWASTP(50), SETRIM(50), SKERFE(50)
110 READ B1,I5,S1,S2,S3,S4,S5,W1
120 DATA 0,0,0,0,0,0,0,0
130 INPUT "Enter the cutting bill number as CBn. Example: CB1.";CBN$
140 CBNA$="B:"+CBN$+CHR$(46)+"DAT"
150 REM Read the cutting bill data here
160 OPEN "I",#1,CBNA$
170 INPUT #1, BMO$,BBN$,BBS$,BBC$,BBST$,BBZ$,BBO$,S$,Q$,TH$,STD$,CBN$,D$,NC
180 FOR I=1 TO NC STEP 1
190 INPUT #1, WLT(I),BL(I),WT(I),NN(I),CA,PN$
200 NEXT I
210 INPUT #1, ITT
220 FOR I=1 TO ITT STEP 1
230 INPUT #1, ITS(I), ITE(I)
240 NEXT I
250 CLOSE #1
260 CLS
270 PRINT "THIS BLANKS PROGRAM IS USED FOR MULTIPLE BLANK LENGTH CALCULATIONS"
280 PRINT "THIS PROGRAM REQUIRES FILE DATA INPUT FROM DRIVE B"
290 PRINT
300 REM Enter the blank width and price per blank length here
310 FOR I=1 TO ITT STEP 1
320 PRINT TAB(5) " Enter the Width and Price for Blank length";
330 XD=ITE(I)
340 PRINT TAB(50) BL(XD);
350 PRINT TAB(55) "inches"
360 INPUT "Enter Blank Width in inches and Blank Price in Dollars"; BWTX(I),BPRI
CEX(I)
370 NEXT I
380 PRINT "Data is now entered. Computing is being done"
390 REM The XX loop goes once for each blank length used
400 FOR XX=1 TO ITT STEP 1
410 BLANKS=0: REGLUE=0: WASTE=0
420 CSQFT=0: ETRIM=0
430 XD=ITE(XX)
440 BLT=BL(XD)
450 BWT=BWTX(XX)
460 BPRICE=BPRICEX(XX)
470 N=ITE(XX)
480 REM The I loop goes once for each part
490 FOR I=ITS(XX) TO ITE(XX) STEP 1
500 CSQFT= (WLT(I)*WT(I)*NN(I))/144+CSQFT
```

```

0 ETRIM= ETRIM+((BLT-WLT(I))*WT(I)*NN(I))/144
0 NNE(I)=NN(I)
0 NEXT I
0 FOR I=ITS(XX) TO ITE(XX) STEP 1
0 IF NNE(I)<=0 THEN 1160 ELSE 560
0 B=BWT/(WT(I)+.125)
0 B=FIX(B)
0 BCHECK= B*(WT(I)+.125)+WT(I)
0 IF BCHECK<=BWT THEN B=B+1 ELSE 600
0 BN=NNE(I)/B
0 IF (BN-FIX(BN))=0! THEN 650 ELSE 630
0 BN1=1-(BN-FIX(BN))
0 GOTO 660
0 BN1=0
0 IF BN1>0 THEN BLANKS=BLANKS+1 ELSE 670
0 BLANKS=BLANKS+FIX(BN)
0 NNE(I)=0
0 REM BN1 is fraction of last blank left
0 W=BWT-B*(WT(I)+.125)
0 IF W>=1 THEN 740 ELSE 720
0 WASTE=WASTE+BN*W
0 GOTO 1020
0 IF I<N THEN 800 ELSE 770
0 II=II+1
0 IF II>N THEN 770 ELSE 810
0 REGLUE=REGLUE+BN*W*BLT
0 GOTO 1020
0 REM Can edging be used?
0 II=I+1
0 IF WT(II)>W THEN 750 ELSE 820
0 IF NNE(II)<=0 THEN 950 ELSE 830
0 BS=W/(WT(II)+.125)
0 BS=FIX(BS)
0 IF BS=0 THEN BS=1 ELSE 860
0 BND=NNE(II)/BS
0 IF BND<BN THEN 920 ELSE 880
0 NNE(II)=NNE(II)-(BS*BN)
0 REM Redefine W after secondary cuttings have been removed AMR (AMR??)
0 W=W-(WT(II)+.125)*BS
0 IF W>=1 THEN 750 ELSE 1020
0 NNE(II)=0
0 IF II=N THEN 970 ELSE 940
0 BN=BN-BND
0 II=II+1
0 IF II>N THEN 770 ELSE 810
0 REGLUE=REGLUE+(BLT*W*(BN-BND))
0 GOTO 1160
0 REGLUE=REGLUE+BLT*BN1*BWT
00 GOTO 1160

```

```

1010 REM Use fraction of last blank
1020 IF BN1=0 THEN 1160 ELSE 1030
1030 II=I+1
1040 IF II>N THEN 990 ELSE 1050
1050 IF NNE(II)>0 THEN 1080 ELSE 1060
1060 II=II+1
1070 GOTO 1040
1080 LPC=(BN1*BWT)/(WT(II)+.125)
1090 IF LPC>NNE(II) THEN 1130 ELSE 1100
1100 NNE(II)=NNE(II)-LPC
1110 BN1=0
1120 GOTO 1160
1130 BN1=((BN1*BWT)-(WT(II)+.125)*NNE(II))/BWT
1140 NNE(II)=0
1150 GOTO 990
1160 NEXT I
1170 TCOST=BLANKS*BPRICE*BLT*BWT/144
1180 BVOL=BLANKS*BLT*BWT/144
1190 REGP=REGLUE/1441/BVOL
1200 REGLUE=REGLUE/144
1210 UTILP=CSQFT/BVOL
1220 I5=I5+1
1230 SBLT(I5)=BLT
1240 SBWT(I5)=BWT
1250 SBSQFT(I5)=BVOL
1260 SCSQFT(I5)=CSQFT
1270 SUTILP(I5)=UTILP*100
1280 BBLANK(I5)=BLANKS
1290 STCOST(I5)=TCOST
1300 SREGP(I5)=REGP*100
1310 SRGVAL(I5)=TCOST*REGP
1320 SETRIM(I5)=(ETRIM/BVOL)*100
1330 SWASTP(I5)=(11-UTILP-REGP)*100
1340 SKERFE(I5)=SWASTP(I5)-SETRIM(I5)
1350 S1=S1+SBSQFT(I5)
1360 S2=S2+SCSQFT(I5)
1370 S3=S3+REGLUE
1380 S4=S4+TCOST
1390 S5=S5+TCOST*REGP
1400 B1=B1+BLANKS
1410 W1=W1+ETRIM
1420 N10=0
1430 CYIELD=S2/S1*100
1440 RYIELD=S3/S1*100
1450 WYIELD=100-CYIELD-RYIELD
1460 W12=W1/S1*100
1470 W13=WYIELD-W12
1480 NEXT XX
1490 CLS
1500 N10=N10+1

```

```

10 OD1$="      ###.###x##      #,####      ##,###.      ##,###.      ##.##      ##,###.##
   #.#.#"
20 OD2$="      ###.###x##      #.#.##      ##,###.##      ##.##      ##.##      ##.##"
30 OD3$="      ###.###      #.#.##      ###,###"
40 OD4$="###.##"
50 OD5$="      Totals      #,####      ##,###.      ##,###.      ##.##      ##,###.##
   #.#.##      #.#.##      #.#.##"
60 OD6$="      Totals      #.#.##      ##,###.##      ##.##      ##.##      ##.##"
70 PRINT:
80 PRINT "          BLANKS BY XYZ CORPORATION"
90 PRINT
100 PRINT TAB(10) "Date";
100 PRINT TAB(16) D$;
100 PRINT TAB(45) "Order No";
100 PRINT TAB(55) BMO$
100 PRINT
100 PRINT "CUSTOMER: Name:";
100 PRINT TAB(20) BBN$;
100 PRINT TAB(45) "Order No.";
100 PRINT TAB(65) BBO$
100 PRINT TAB(8) "Street:";
100 PRINT TAB(20) BBS$;
100 PRINT TAB(55) "CB Number:";
100 PRINT TAB(62) CBN$
100 PRINT TAB(10) "City.";
100 PRINT TAB(20) BBC$;
100 PRINT TAB(30) BBST$;
100 PRINT TAB(35) BBZ$
100 PRINT
100 PRINT " Blank Specifications:";
100 PRINT TAB(25) S$;
100 PRINT TAB(45) Q$;
100 PRINT TAB(55) TH$;
100 PRINT TAB(60) STD$
100 IF N10=1 THEN 1840 ELSE 1960
100 PRINT
100 PRINT TAB(8) " Blank Size      Blanks      Blanks      Parts      Yield      Price
Price"
100 PRINT TAB(8) " (inches)      (number)      (sqft)      (sqft)      (%)      (dollars
($/sqft)"
100 PRINT
100 FOR I6=1 TO I5 STEP 1
100 PRINT USING OD1$;SBLT(I6);SBWT(I6);BBLANK(I6);SBSQFT(I6);SCSQFT(I6);SUTILP(
6;STCOST(I6);BPRICEX(I6)
100 NEXT I6
100 PRINT
100 PRINT USING OD5$;B1;S1;S2;CYIELD;S4
100 PRINT "Hit F5 to see page 2"
100 STOP
100 GOTO 1490
100 PRINT: PRINT: PRINT
100 PRINT TAB(8) "Blank Size      Reglue      Reglue      End Waste Edge Waste Total"
100 PRINT TAB(8) " (inches)      (%)      Value($)      (%)      (%)      Waste(%)
100 PRINT
100 FOR I6=1 TO I5 STEP 1

```

```

2010 PRINT USING OD2$;SBLT(I6);SBWT(I6);SREGP(I6);SRGVAL(I6);SETRIM(I6);SKERFE(I
6);SWASTP(I6)
2020 NEXT I6
2030 PRINT
2040 PRINT USING OD6$;RYIELD;S5;W12;W13;WYIELD
2050 INPUT "Enter 1 to print the results. Enter 2 for another run";XJ
2060 IF XJ=1 THEN 2070 ELSE END
2070 LPRINT: LPRINT: LPRINT
2080 LPRINT TAB(10) CHR$(14);" BLANKS BY XYZ CORPORATION"
2090 LPRINT
2100 LPRINT TAB(10) "Date";
2110 LPRINT TAB(16) D$;
2120 LPRINT TAB(45) "Order No.";
2130 LPRINT TAB(55) BMO$
2140 LPRINT
2150 LPRINT "CUSTOMER: Name:";
2160 LPRINT TAB(20) BBN$;
2170 LPRINT TAB(55) "Order No.";
2180 LPRINT TAB(65) BBO$
2190 LPRINT TAB(8) "Street:";
2200 LPRINT TAB(20) BBS$;
2210 LPRINT TAB(55) "CB Number:";
2220 LPRINT TAB(66) CBN$
2230 LPRINT TAB(10) "City.";
2240 LPRINT TAB(20) BBC$;
2250 LPRINT TAB(30) BBST$;
2260 LPRINT TAB(35) BBZ$
2270 LPRINT
2280 LPRINT " Blank Specifications:";
2290 LPRINT TAB(25) S$;
2300 LPRINT TAB(45) Q$;
2310 LPRINT TAB(50) TH$;
2320 LPRINT TAB(55) STD$
2330 LPRINT
2340 LPRINT TAB(8) " Blank Size      Blanks      Blanks      Parts      Yield      Price
Price"
2350 LPRINT TAB(8) " (inches)      (number)      (sqft)      (sqft)      (%)      (dollar
s) ($/sqft)"
2360 LPRINT
2370 FOR I6=1 TO I5 STEP 1
2380 LPRINT USING OD1$;SBLT(I6);SBWT(I6);BBLANK(I6);SBSQFT(I6);SCSQFT(I6);SUTIL
(I6);STCOST(I6);BPRICEX(I6)
2390 NEXT I6
2400 LPRINT
2410 LPRINT USING OD5$;B1;S1;S2;CYIELD;S4
2420 LPRINT: LPRINT: LPRINT
2430 LPRINT TAB(8) "Blank Size      Reglue      Reglue      End Waste      Edge Waste      Total"
2440 LPRINT TAB(8) " (inches)      (%)      Value($      (%)      (%)      Waste(
)"
2450 LPRINT
2460 FOR I6=1 TO I5 STEP 1
2470 LPRINT USING OD2$;SBLT(I6);SBWT(I6);SREGP(I6);SRGVAL(I6);SETRIM(I6);SKERFE
(I6);SWASTP(I6)
2480 NEXT I6
2490 LPRINT
2500 LPRINT USING OD6$;RYIELD;S5;W12;W13;WYIELD
2510 LPRINT CHR$(12)
2520 END

```

```

0 REM This program is used to print sorted CB files with iteration controls
0 REM This program is saved as "A:CBPRINT.BAS"; written in BASICA
0 DIM PL(100),PW(100),PQ(100),CA(100),PN$(100),BL(100),LN(100),ITS(13),ITE(13)
0 DIM SPL(100),SPW(100),SPQ(100),SCA(100),SPN$(100),SBL(100),SLN(100)
0 ITT=1: ITS(1)=0: ITE(1)=0
0 INPUT "Enter cutting bill name. Example CB1"; CBN$
0 CBNA$="B:"+CBN$+CHR$(46)+"DAT"
0 CLS
0 OPEN "I",#1,CBNA$
00 INPUT #1, BMO$,BBN$,BBS$,BBC$,BBST$,BBZ$,BBO$,S$,Q$,TH$,STD$,CBN$,D$,NC
10 FOR I=1 TO NC STEP 1
20 INPUT #1, PL(I),BL(I),PW(I),PQ(I),CA(I),PN$(I)
30 NEXT I
40 INPUT #1, ITT
50 FOR I=1 TO ITT STEP 1
60 INPUT #1, ITS(I),ITE(I)
70 NEXT I
80 CLOSE #1
90 OD1$="###.###.###.###.###.###.###.###.###.### \\"
    \"
00 CLS
10 PRINT TAB(10) CHR$(14); "BLANKS BY XYZ CORPORATION";
20 PRINT
30 PRINT TAB(10) "Date";
40 PRINT TAB(16) D$;
50 PRINT TAB(45) "Order No.";
60 PRINT TAB(55) BMO$
70 PRINT
80 PRINT "Customer Name:";
90 PRINT TAB(20) BBN$;
00 PRINT TAB(55) "Order No.";
10 PRINT TAB(65) BBO$
20 PRINT TAB(8) "Street:";
30 PRINT TAB(20) BBS$;
40 PRINT TAB(55) "CB Number:";
50 PRINT TAB(66) CBN$
60 PRINT TAB(10) "City:";
70 PRINT TAB(20) BBC$;
80 PRINT TAB(30) BBST$;
90 PRINT TAB(35) BBZ$
00 PRINT
10 PRINT " Blank Specifications:";
20 PRINT TAB(25) S$;
30 PRINT TAB(45) Q$;
40 PRINT TAB(55) TH$;
50 PRINT TAB(60) STD$
60 PRINT
70 PRINT "Line Blank Part Part Part Case Part"
80 PRINT "No. Length Length Width Quantity Number Name"
90 PRINT " (in) (in) (in) (number)"
00 FOR I=1 TO NC STEP 1
10 PRINT USING OD1$;I,BL(I),PL(I),PW(I),PQ(I),CA(I),PN$(I)
20 NEXT I
30 PRINT
40 PRINT TAB(5) "Number of Different Blank Lengths";

```

```

550 PRINT TAB(41) ITT
560 FOR I=1 TO ITT STEP 1
570 PRINT TAB(5) "Line No. Blank Length Start";
580 PRINT TAB(32) ITS(I);
590 PRINT TAB(40) "Line no. Blank Length End";
600 PRINT TAB(66) ITE(I)
610 NEXT I
620 INPUT "Enter 1 to print cutting bill. Enter 2 to end program";X2
630 IF X2=1 THEN 640 ELSE END
640 LPRINT: LPRINT: LPRINT
650 LPRINT TAB(10) CHR$(14);"BLANKS BY XYZ CORPORATION"
660 LPRINT
670 LPRINT TAB(10) "Date";
680 LPRINT TAB(16) D$;
690 LPRINT TAB(45) "Order No.";
700 LPRINT TAB(55) BMO$
710 LPRINT
720 LPRINT "Customer Name:";
730 LPRINT TAB(20) BBN$;
740 LPRINT TAB(55) "Order No.";
750 LPRINT TAB(65) BBO$
760 LPRINT TAB(8) "Street:";
770 LPRINT TAB(20) BBS$;
780 LPRINT TAB(55) "CB Number:";
790 LPRINT TAB(66) CBN$
800 LPRINT TAB(10) "City:";
810 LPRINT TAB(20) BBC$;
820 LPRINT TAB(30) BBST$;
830 LPRINT TAB(35) BBZ$
840 LPRINT
850 LPRINT " Blank Specifications:";
860 LPRINT TAB(25) S$;
870 LPRINT TAB(45) Q$;
880 LPRINT TAB(50) TH$;
890 LPRINT TAB(55) STD$
900 LPRINT
910 LPRINT "Line Blank Part Part Part Case Part"
920 LPRINT "No. Length Length Width Quantity Number Name"
930 LPRINT " (in) (in) (in) (number)"
940 FOR I=1 TO NC STEP 1
950 LPRINT USING OD1$;I;BL(I);PL(I);PW(I);PQ(I);CA(I);PN$(I)
960 NEXT I
970 LPRINT
980 LPRINT TAB(5) "Number of Different Blank Lengths";
990 LPRINT TAB(41) ITT
1000 LPRINT TAB(5) "Line No. Blank Length Start";
1010 LPRINT TAB(40) "Line no. Blank Length End"
1020 FOR I=1 TO ITT STEP 1
1030 LPRINT TAB(32) ITS(I);
1040 LPRINT TAB(66) ITE(I)
1050 NEXT I
1060 LPRINT CHR$(12)
1070 END

```

ENDIX IV: Program CBIPRINT

```
EM This program is used to print CBINDEX file
EM This program is saved as "A:CBIPRINT.BAS"; written in BASICA
IM BMO$(100),BBN$(100),BBS$(100),BBC$(100),BBST$(100),BBZ$(100)
IM BBO$(100),S$(100),Q$(100),TH$(100),STD$(100),CBN$(100),D$(100),NC(100)
=0
PEN "I",#1,"B:CBINDEX.DAT"
OR I=1 TO 100 STEP 1
NPUT #1, BMO$(I),BBN$(I),BBS$(I),BBC$(I),BBST$(I),BBZ$(I),BBO$(I),S$(I),Q$(I)
$(I),STD$(I),CBN$(I),D$(I),NC(I)
=N+1
IF EOF(1) THEN 130
NEXT I
CLOSE #1
CLS
FOR I=1 TO N STEP 1
PRINT TAB(10) CHR$(14); "BLANKS BY XYZ CORPORATION";
PRINT
PRINT TAB(10) "Date";
PRINT TAB(16) D$(I);
PRINT TAB(45) "Order No.";
PRINT TAB(55) BMO$(I)
PRINT
PRINT "Customer Name:";
PRINT TAB(20) BBN$(I);
PRINT TAB(55) "Order No.";
PRINT TAB(65) BBO$(I)
PRINT TAB(8) "Street:";
PRINT TAB(20) BBS$(I);
PRINT TAB(55) "CB Number:";
PRINT TAB(66) CBN$(I)
PRINT TAB(10) "City:";
PRINT TAB(20) BBC$(I);
PRINT TAB(30) BBST$(I);
PRINT TAB(35) BBZ$(I)
PRINT
PRINT " Blank Specifications:";
PRINT TAB(25) S$(I);
PRINT TAB(45) Q$(I);
PRINT TAB(55) TH$(I);
PRINT TAB(60) STD$(I)
PRINT: PRINT
NEXT I
INPUT "Enter 1 to print cutting billindex. Enter 2 to end program";X2
IF X2=1 THEN 440 ELSE END
FOR I=1 TO N STEP 1
LPRINT: LPRINT: LPRINT
LPRINT TAB(10) CHR$(14);"BLANKS BY XYZ CORPORATION"
LPRINT
LPRINT TAB(10) "Date";
LPRINT TAB(16) D$(I);
LPRINT TAB(45) "Order No.";
```

```

510 LPRINT TAB(55) BMO$(I)
520 LPRINT
530 LPRINT "Customer Name:";
540 LPRINT TAB(20) BBN$(I);
550 LPRINT TAB(55) "Order No.";
560 LPRINT TAB(65) BBO$(I)
570 LPRINT TAB(8) "Street:";
580 LPRINT TAB(20) BBS$(I);
590 LPRINT TAB(55) "CB Number:";
600 LPRINT TAB(66) CBN$(I)
610 LPRINT TAB(10) "City:";
620 LPRINT TAB(20) BBC$(I);
630 LPRINT TAB(30) BBST$(I);
640 LPRINT TAB(35) BBZ$(I)
650 LPRINT
660 LPRINT " Blank Specifications:";
670 LPRINT TAB(25) S$(I);
680 LPRINT TAB(45) Q$(I);
690 LPRINT TAB(50) TH$(I);
700 LPRINT TAB(55) STD$(I)
710 LPRINT: LPRINT
720 NEXT I
730 END

```

Reynolds, Hugh W.; Araman; Philip A. Program BLANKS on the IBM-PC. Gen. Tech. Rep. NE-107. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1986. 28 p.

Describes a computer program that allows a company to determine the number of edge-glued, standard-size blanks needed to satisfy the rough-part needs specified in a given cutting bill. Program BLANKS has been written in FORTRAN using 80 column card input for use on a mainframe computer. The program has been translated to BASICA for use on the IBM-PC. Also described are rough-part cutting bill input file creation and manual sorting programs. A sample rough-part cutting bill and a blanks analysis are included.

ODC 836.1; 847.1/2

Keywords: Low-grade utilization, hardwood dimension

Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
 - Berea, Kentucky, in cooperation with Berea College.
 - Burlington, Vermont, in cooperation with the University of Vermont.
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 - Durham, New Hampshire, in cooperation with the University of New Hampshire.
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 - University Park, Pennsylvania, in cooperation with the Pennsylvania State University.
 - Warren, Pennsylvania.
-

New England Wildlife: Habitat, Natural History, and Distribution

Richard M. DeGraaf
Deborah D. Rudis



Amphibians



Reptiles



Birds



Mammals

ABSTRACT

Describes natural history profiles of New England wildlife species and their associations with forested and nonforested habitats. Provides a data base that will enable forest managers or wildlife biologists to describe the species or groups to be found in a given habitat.

THE AUTHORS

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This report is a contribution to the Wildlife and Fish Habitat Relationships Program of the U.S. Department of Agriculture, Forest Service. Professional concerns for wildlife community, management, as well as recent legislation, such as the National Forest Management Act of 1976, have given impetus to the Program, which seeks to maintain viable populations of all existing native vertebrates on lands administered by the Forest Service. To achieve this broad goal, the habitats, life histories, and distributions of all vertebrates that potentially inhabit management units must be compiled in a standard habitat classification scheme. When species occurrences have been verified for the area under consideration, management indicator species can be monitored to detect population changes. Indicator species must include federally listed endangered species; species whose special habitat components may be affected by management practices; species commonly hunted, fished, or trapped; and, finally, species whose population changes likely reflect the impacts of management activities on other wildlife species in the community. While routine monitoring of indicator species to detect population changes of other species is a future goal, all efforts toward the development of such a procedure must be based on accurate biological knowledge and habitat associations. Thus this report, the stimulus for which came from the development of guidelines for the management of wildlife in the Blue Mountains of Oregon and Washington (Thomas 1979). The format closely follows that of Verner and Boss (1980) in order to contribute to a national compilation of forest-wildlife habitat relationships.

Our approach was to compile the available information on the life history, distribution, and habitat for each inland vertebrate occurring in New England and then obtain critical reviews by known experts. This report is based partly on information that was originally available in three separate volumes on northeastern wildlife. The original volumes were limited and were intended for USDA Forest Service use in wildlife habitat management on the Green Mountain and White Mountain National Forests:

DeGraaf, R.M.; Witman, G.M.; Lanier, J.W.; Hill, B.J.; Keniston, J.M. Forest habitat for birds of the Northeast. Milwaukee, WI: Forest Service, Eastern Region; 1980. 589 p.

DeGraaf, R.M.; Witman, G.M.; Rudis, D.D. Forest habitat for mammals of the Northeast. Milwaukee, WI: U.S. Department of Agriculture, Forest Service, Eastern Region; 1981. 182 p.

DeGraaf, R.M.; Rudis, D.D. Forest habitat for reptiles and amphibians of the Northeast. Milwaukee, WI: U.S. Department of Agriculture, Forest Service, Eastern Region; 1981. 239 p.

We trust that this information contributes to the sound management of forest wildlife communities in New England and elsewhere. We urge researchers to field check the information in the species/habitat matrices; such work is vital before the application of indicator species to wildlife management.

INTRODUCTION

New England's forests provide a diversity of habitats that support a range of wildlife communities. Now mostly forested, the New England landscape has changed dramatically in the last 350 years. Once covered by the primeval forest, the land was cleared for agriculture, slowly until about 1750, then at an increased pace until 1820, when 75 percent of the arable land in southern and central New England was in farm crops and pasturage. A century later, these figures were reversed, and New England was about 75 percent forested — the result of an era of farm abandonment that began in 1830 with the opening of rich farmlands in Ohio via the Erie Canal. The building of railroads, the Civil War, and even the California gold rush all contributed to the exodus of farmers from the stony hills so arduously brought under cultivation.

The reversion of the land to forest began at once, producing the "old field" pine stands that reached harvestable size just after the turn of the 20th century. Today, New England supports a diversity of forest cover types. Major types include eastern white pine/northern red oak/red maple, red spruce, paper birch, northern hardwoods, spruce-fir, (Fig. 1). In some areas, admixtures of aspen, paper birch, red maple, hemlock, as well as many open, wetland, and other habitats occur.

Forest management activities — primarily timber harvest, fuelwood management, and road building — are the dominant influences on wildlife habitats. This publication presents the habitat associations of all inland species of New England wildlife in one habitat classification scheme. This information will provide forest managers, wildlife biologists, and other resource specialists with a ready source of information on the habitat needs of all forest wildlife species in New England, and thereby will assure the continued existence of all important, appropriate wildlife habitats in the managed forests of New England. The key to planning the management of all wildlife species is to know their habitat requirements and to provide them in a variety of combinations that meet the needs of as many species as possible. To this end, wildlife must be viewed as wildlife communities that respond over time to habitat changes.

Management of wildlife on public lands is a responsibility shared by various state and federal land management agencies. By agreement, states generally manage or regulate wildlife populations and federal agencies manage habitats. Naturally, close cooperation is required to meet wildlife management goals. This manual provides only habitat information — wildlife population goals must be developed through the coordination or activities of all involved agencies.

Traditionally, wildlife management — whether on federal, state, or private lands — was concerned primarily with game species. The reason for this emphasis is simple — the basic sources of funds for wildlife management were derived from hunters' expenditures, pur-

chase of licenses, and payment of an excise tax on sporting arms and ammunition through the Pittman-Robertson Act, otherwise known as the "Federal Aid to States in Wildlife Restoration Act" (P.L. 75-415, as amended).

Recent legislation has mandated that ecological considerations have an important role in forest management and related resource-use decisions. These statutes that require that land management practices recognize all wildlife include:

Fish and Wildlife Coordination Act (16 U.S.C. 661-666c, 1934 as amended): Seeks to protect fish and wildlife habitats by requiring the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to review and report on proposed water and associated land development projects. Evaluations cover projects receiving funds through the Federal River and Harbor Act of 1899, Sections 402 and 404 of the Federal Water Pollution Control Act as amended 1972, and other appropriate Acts.

Multiple Use and Sustained Yield Act of 1960 (P.L. 86-517): Directs the USDA Forest Service to consider all renewable resources in conjunction with one another.

National Environmental Policy Act of 1969 (P.L. 91-190): Encourages productive harmony among man and his environment; requires that any federally financed project be evaluated and environmental impacts, including those on fish and wildlife, and alternative opportunities, be identified.

Endangered Species Act of 1973 (P.L. 93-205): Calls for conservation of endangered and threatened species, and of the ecosystems supporting them. Critical habitats required to assure survival and restoration of endangered species are identified, delineated, and maintained.

Sikes Act of 1974 (P.L. 93-452): Calls for new directions and cooperation with the states in planning and management of wildlife habitat on federal lands.

Forest and Rangeland Renewable Resources Planning Act of 1974 (P.L. 93-378): Directs the USDA Forest Service to inventory natural resources in the National Forest System and provide comprehensive plans for their management.

Federal Land Policy and Management Act of 1976 (P.L. 94-579): Established national policy to retain rather than dispose of the National Resource Lands, and directs that those lands be inventoried, uses be planned on a multiple-use and sustained-yield basis, and that lands be managed on a sound ecological basis, with habitat provided for fish and wildlife. Land use plans and regulations must include protection of public land areas of critical en-

Figure 1. Forest cover types — aspen, paper birch, northern hardwoods, red maple, northern red oak, white pine/northern red oak-red maple, balsam fir, eastern white pine, red spruce-balsam fir, red spruce, and eastern hemlock.

ASPEN



Twin Mountain, New Hampshire
August 1985



Forest Milan, New Hampshire
August 1985

PAPER BIRCH



Gorham, New Hampshire
August 1985



Berlin, New Hampshire
July 1984



Amherst, Massachusetts
July 1985

WHITE PINE — NORTHERN RED OAK — RED MAPLE



Belchertown, Massachusetts
August 1985

NORTHERN RED OAK



Ware, Massachusetts
August 1985

EASTERN WHITE PINE



Underland, Massachusetts
July 1985



Berlin, New Hampshire
August 1985



Mt. Tabor, Vermont
June 1948



Petersham, Massachusetts
August 1985

vironmental concern. This refers to delineated areas of public lands where special management attention is required to protect and prevent irreparable damage to important fish and wildlife resources or other natural systems or processes. In resource inventories, priority shall be given to designation and protection of areas of critical environmental concern.

National Forest Management Act of 1976 (P.L. 94-588):
Requires, among other things, that research be conducted to ensure that land management systems will not substantially impair land productivity.

Wildlife habitat improvement continues to be an integral part of the management of the national forests. All wildlife species have important roles — functions — in ecosystems, and so, must be considered in land management practices. The broad objective of the wildlife habitat program of the Eastern Region of the Forest Service is

to maintain a diversity of habitats to ensure that populations of all native wildlife species and communities continue to be represented on the national forests.

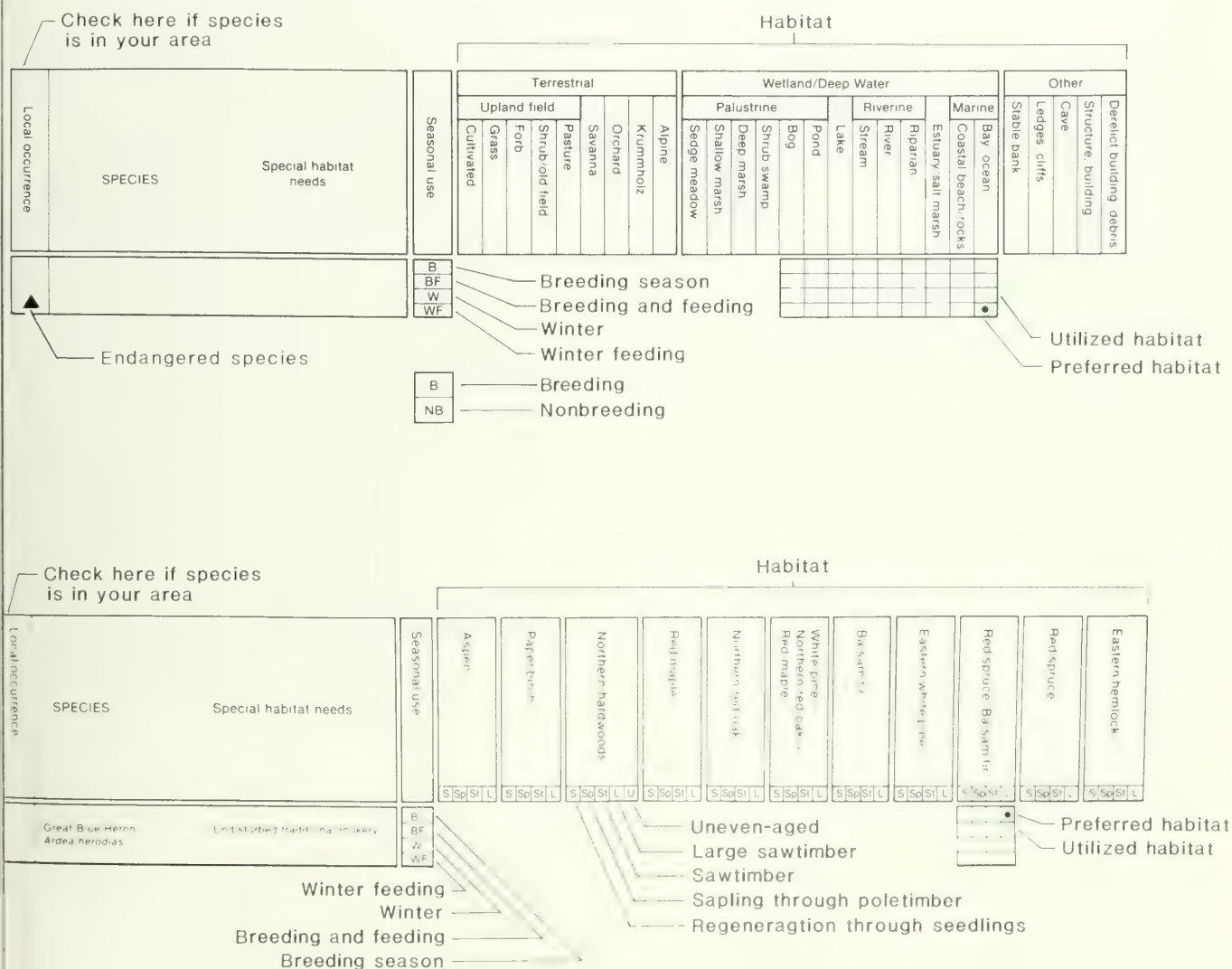
Species Included

Notes on life history and habitat associations of 338 inland (nonmarine) species, grouped into sections by taxonomic class, are included in this report. Species within each class are arranged in phylogenetic order. Special status designations for certain species are listed in the Appendix. Additional groups of strictly coastal, migratory, and accidental species are not covered in detail but are also listed in the Appendix.

Species/Habitat Matrices

Species habitat matrices present summary information in a simple, condensed, tabular form (Fig. 2). These matrices are the most important parts of the report. Familiarize yourself with their arrangement and the ele-

Figure 2.—The key to elements in the species/habitat matrices.



ments that they contain. Two sets of matrices are provided, one for forest cover types, another for nonforest types — terrestrial, wetlands, and other habitats.

Special Habitat Features

Special habitat features are listed for many species. These features are considered to be essential for that species to occur regularly or to reproduce. Many species are generally associated with a given forest type or group of types — cavity-nesting waterfowl, for example. But the special habitat feature — here it is water — must also be present. Thus, the species/habitat associations must be viewed as a complex of within-stand or special habitat requirements occurring in species' overall or general habitat. Some special habitat features can be provided through forest management — the aforementioned cavities, for example, either by delayed rotation or streamside buffer strips where timber harvest is prohibited — but the stream or pond cannot.¹ The special habitat features entered in the matrices are taken from the larger classification below.

Aquatic

- Open water
- Shallow marsh 1.5 feet (0.5 m)
- Moderate depth 1.5 to 6 feet (6.5 to 1.8 m), at least 1 acre (0.4 ha)
- Deep marsh > 6 feet (1.8 m)
- Submerged vegetation — typically coontail (*Ceratophyllum*)
- Floating vegetation — typically spatterdock (*Nuphar*) or pond lily (*Nymphaea*)
- Emergent vegetation — cattail (*Typha*) or bulrush (*Scirpus*)
- Shrubs at water's edge
- *Dead standing trees 6 to 8 inches (1.5 to 20 cm) d.b.h.
- *Dead standing trees 9 to 12 inches (23 to 30 cm) d.b.h.
- *Dead standing trees 13 to 19 inches (33 to 48 cm) d.b.h.
- *Dead standing trees > 20 inches (51 cm) d.b.h.
- Down and decaying trees at present
- Islands present
- Springs
- Stream banks — grass — topped, (stable)
- Banks
- Relatively stable water level
- Intermittent stream flow
- Small stream < 10 feet (3 m) wide
- River
- *Light shade on water — 10 to 25 percent
- *Moderate shade on water — 25 to 75 percent
- *Deep shade > 75 percent
- Bedrock bottom
- Boulder bottom
- Cobble bottom

Gravel bottom

Sand bottom

Mud bottom

Organic bottom

Flow < 50 cubic feet per second (1.5 m³ per second) mean annual flow

Flow between 50 to 1,000 cubic feet per second mean annual flow (1.5 to 28 m³ per second)

Flow between 1,000 to 5,000 cubic feet per second mean annual flow (28 to 142 m³ per second)

Flow > 5,000 cubic feet per second mean annual flow (140 m³ per second)

Water temperature 32 °F to 50 °F (0 °C to 10 °C)

Water temperature 51 °F to 70 °F (11 °C to 21 °C)

Water temperature 71 °F to 80 °F (22 °C to 27 °C)

Water temperature > 81 °F (27 °C)

High O₂ concentrations — > 9 ppm (9 mg/L)

Moderate O₂ concentrations — 6 to 9 ppm (6 to 9 mg/L)

Low O₂ concentrations — < 6 ppm (6 mg/L)

High pH level — > 8.4

Moderately high pH level — 7.1 to 8.4

Neutral pH — 7.0

Moderately low pH — 6.9 to 5.6

Low pH — < 5.6

Terrestrial characteristics (stand area)

- * 1 to 10 acres (0.4 to 4 ha)
- * 11 to 50 acres (4.5 to 20 ha)
- * 51 to 200 acres (21 to 80 ha)
- * 201 to 500 acres (81 to 200 ha)
- * 501 to 1,000 acres (22 to 400 ha)

Locators

- *Forest interior
 - Aquatic — terrestrial ecotone
- *Opening — shrub land ecotone
- *Opening — wood and ecotone
- *Shrubland — forest ecotone
- *In opening interior

Canopy features

- *None
- Scattered < 1 percent to 4 percent closure
- *Open 5 percent to 30 percent closure
- *Moderately closed 30 percent to 60 percent
- *Closed > 60 percent closure

Dead trees

- * < 6 inches (15 cm)
- * 6 to 8 inches (15 to 20 cm)
- * 9 to 12 inches (23 to 30 cm)
- * 13 to 19 inches (33 to 48 cm)
- * > 20 inches (51 cm)

¹Special habitat features that can be provided through forest management are marked with an asterisk (*).

Structure

- * Canopy only
- * Canopy with one intermediate layer
- * Canopy with two intermediate layers

Other features (man made)

- Abandoned buildings
- Dumps
- Railroad grades
- Power lines
- Manure piles
- * Sawdust piles
- Mine spoils

Ground cover type

- Exposed soil
- Moss
- Litter
- Rocks
- * Fallen logs
- * Slash piles
- Herbaceous vegetation
- Vines
- Brambles
- Fence rows
- * Ericaceous shrubs
- * Coniferous shrubs
- * Deciduous shrubs
- * Mixed shrubs

Ground cover density

- * Very light, 10 percent or less
- * Light, 11 percent to 30 percent
- * Medium, 31 percent to 50 percent
- * Moderately high, 51 percent to 70 percent
- * High, 71 percent

Opening type

- Lawn, golf course, and so on
- Cultivated
- Fallow field
- Pasture
- * Log landing
- * Abandoned road
- Gravel pit
- Fire
- * Blowdown
- Wet meadow

Soil texture

- Bedrock -- outcrops
- Boulders
- Cobbles
- Gravel

- Sand
- Loam
- Silt
- Clay

Soil permeability

- Rapid
- Moderate
- Slow

Soil pH

- Strongly acid, < 4.5 to 5.0
- Medium acid, 5.1 to 6.5
- Neutral, 6.6 to 7.3
- Medium alkaline, 7.4 to 8.4
- Strongly alkaline, 8.5 +

Forest Cover Types

The forest cover types used to describe forest habitats are based on those in *Forest Cover Types of the United States and Canada* (Eyre 1980). Similar types are grouped, especially when they reflect similarities in wildlife species distribution and habitat selection. We have included descriptions of the types as they pertain to New England. The translation of these types into two other major vegetation classifications is shown in Figure 3. Forest development is indicated by size class as follows:

- S *Regeneration through seedlings:* Live trees and associated vegetation less than 1.0 inch (2.5 cm) d.b.h. and at least 1 foot (30 cm) in height.
- Sp *Sapling through poletimber:* Saplings are live trees 1.0 to 3.9 inches (2.5 to 9.9 cm) d.b.h.; poles are live trees 4.0 to 8.9 inches (10.0 to 22.0 cm) d.b.h. for softwoods and 4.0 to 11.9 inches (10.0 to 30.0 cm) d.b.h. for hardwoods. The matrix assumes that stands are fully stocked, that is, contain approximately 75 square feet of basal area per acre.
- St *Sawtimber:* A stand with at least half of the stocking in sawtimber-size trees — at least 9.0 inches (23 cm) d.b.h. for softwoods or 12.0 inches (31 cm) for hardwoods.
- L *Large sawtimber:* A stand with at least half of the stocking in large-sawtimber trees — at least 20 inches (51.0 cm) d.b.h. for softwoods and 24 inches (61.0 cm) d.b.h. for hardwoods.
- U *Uneven-aged:* Stands of northern hardwood-cover types that contain trees of all size classes.

Figure 3. Translation of the Society of American Forester's cover types into two other major vegetation classifications used in New England.

Society of American Foresters Forest Cover Types & Numbers (Eyre 1980)	Potential Natural Vegetation of the U.S. (Kuchler 1964)	Ecoregions of the U.S. (Bailey 1980)
Red Spruce-Balsam Fir 33 Northern White Cedar 37	Conifer Bog 94	Northern Hardwoods-Spruce 2114
Red Spruce 32	Northeastern Spruce-Fir Forest 96	
Balsam Fir 5	Northern Hardwoods-Spruce Forest 108	
Aspen 16		
Paper Birch 18	Transition between Northern Hardwoods and Appalachian Oak 109	Northern Hardwoods 2113
Eastern Hemlock 23	Northern Hardwoods 106	
Sugar Maple-Beech-Yellow Birch 25 Sugar Maple 27 Beech-Sugar Maple 60	Appalachian Oak 104	
White Pine 21 Red Pine 15 White Pine-Hemlock 22		
Northern Red Oak 55		
White Pine-Northern Red Oak - Red Maple 20	North-eastern Oak-Pine 110	Appalachian Oak 2214
Red maple 108 Black Ash-American Elm-Red Maple 39	No provision	
	No provision	No provision

These apply to all forest cover types *under even-age management*, with one exception. Only in the northern hardwoods cover-type group do we list wildlife habitat associations for uneven-aged stands.

Common and scientific names of trees follow Little's (1979) *Checklist of United States Trees*. Names of understory plants follow *Gray's Manual of Botany* (Fernald 1950).

The forest cover types and groups are:

- *Aspen*: This type includes quaking aspen (*Populus tremuloides*) and bigtooth aspen (*Populus grandidentata*) but in New England, quaking aspen is more likely to occur in pure stands. Common associates are paper birch (*Betula papyrifera*) and pin cherry (*Prunus pensylvanica*), which when occurring in admixture, die out

arly. These species occur on a variety of sites and soil types. The aspen type occurs on most soil types except very dry sands or very wet swamps. Aspen is unique in that almost all stands originate as suckers arising from existing root systems. It will sometimes reproduce from seed on burns, clearcuts, and other scarified sites.

Aspen is a relatively short-lived pioneer type — it does not reproduce under its own shade. On dry sites it is replaced by red pine, red maple, or oaks, on mesic sites by white pine, and on fertile sites by northern hardwoods, and on fertile wet sites by balsam fir (Brinkman and Roe 1980).

- *Paper birch*: Paper birch is pure or dominant. Associated species include quaking and bigtooth aspen, balsam fir, red spruce (*Picea rubra*), white pine (*Pinus strobus*), yellow birch (*Betula alleghaniensis*) and, in southern New England, hemlock (*Tsuga canadensis*). The type pioneers on burned areas and clearcuts, and grows best on deep, fertile, well-drained sites. Raspberries and blackberries (*Rubus* spp.) make up a high proportion of the ground cover at the time of establishment in paper birch stands. These are shaded out in about 10 years, but pin cherry can persist for 30 or more years. Paper birch is succeeded by spruce-fir in northern parts of its range, and to the south by northern hardwoods and hemlock on fertile, well-drained sites (Safford 1980).

- *Northern hardwoods* (including sugar maple, sugar maple/beech/yellow birch, and beech/sugar maple): True northern hardwoods are dominated by sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and yellow birch and occur widely as a pure type in northern New England. It grades into a mixed hardwood or transition type in southern New England; associated species throughout the region include basswood (*Tilia americana*), red maple (*Acer rubrum*), hemlock, white ash (*Fraxinus americana*), white pine, balsam fir, black cherry (*Prunus serotina*), paper birch, sweet birch (*Betula lenta*), and red spruce. Northern hardwood is the basic hardwood type in northern New England, and occurs to an elevation of 2,500 feet (760 m). It prefers fertile sandy soils and good moisture conditions. Striped maple (*Acer pensylvanicum*), witch-hazel (*Hamamelis virginiana*), and hobblebush (*Viburnum alnifolium*) are common in the understory throughout the region. Best development of the type occurs on moist, fertile, well-drained sandy soils. On drier sites, beech becomes more prominent. On wet sites, the type blends into a red/yellow birch/hemlock or a red spruce mixture. The type tends to be climax. From New England to Pennsylvania, the beech-nectria complex has gradually reduced the proportion of beech in many stands (Berglund 1980).

- *Red Maple*: Red maple (*Acer rubrum*) is pure or dominant. In New England, red maple and associated species are common on wet sites; the type is essentially pure in southern New England. Associates are yellow birch, balsam fir, and sugar maple in northern New En-

gland; black gum (*Nyssa sylvatica*), sycamore (*Platanus occidentalis*), and silver maple (*Acer saccharinum*) in southern New England. In New England and the Upper Peninsula of Michigan, it occupies moist to wet muck or peat soils in swamps, depressions of slow drainages or along sluggish streams, and so is often found as an inclusion in northern hardwoods on wetter sites (Powell and Erdmann 1980). It can be differentiated readily from northern hardwoods by the absence of beech and the increased proportion of yellow birch and red spruce.

- *Northern red oak*: Northern red oak (*Quercus rubra*) accounts for a majority of the stocking. Associates vary according to site and locale, and include black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*), and chestnut oak (*Q. prinus*), hickories (*Carya* spp.), and red maple. In New England, the type has a spotty distribution, occupying ridge crests and upper north slopes. On better sites, associates are black cherry, sugar maple, white ash (*Fraxinus americana*), and American beech. The type is rare in northern New England and reaches best development in New England in western Massachusetts and northern Connecticut on loam and silt-loam soils. The type is sub-climax — shade tolerant species such as beech and sugar maple increase in proportion over time (Trimble 1980).

- *White Pine/Northern Red Oak/Red Maple*: northern red oak, Eastern white pine (*Pinus strobus*), and red maple predominate; white ash is the most common associate, but others include paper birch, yellow birch (*B. lutea*), and sweet birch (*B. lenta*), sugar maple, beech, hemlock, and black cherry. Occurs across southern and central New England to an elevation of 1,500 feet (450 m), generally on deep, well-drained fertile soils.

This type is common in the transition between northern hardwoods and spruce-fir types in northern New England, and between northern hardwoods and oak types — characteristic of central types — in southern New England. The type often follows “old field” white pine in New England, where hardwood seedlings and saplings form the understory (Baldwin and Ward 1980). Common understory shrubs include witch-hazel, alternate-leaf dogwood (*Cornus alternifolia*), mapleleaf viburnum (*Viburnum acerifolium*), mountain-laurel (*Kalmia latifolia*).

- *Balsam fir*: Balsam fir (*Abies balsamea*) is characteristically pure or predominant. There are many associates mostly on moist or wet-site soils in northern New England; these include paper birch, quaking and bigtooth aspen, red spruce, and in swamps northern white-cedar (*Thuja occidentalis*). In southern New England, hemlock and red maple are common associates. The type is common in northern New England, occurring on upland sites, on low-lying moist flats and in swamps. Pure stands result (usually) from heavy cutting, blowdown, or following infestation of spruce budworm. This type is common in northern New England, and may be climax in the zone

below timberline. Only black spruce (*Picea mariana*) grows above it (Westveld 1953).

The type occurs extensively in Quebec, where five distinct subtypes are recognized. In the United States, the type is not as complex; however, balsam fir is an important component in the following types in northern New England: red spruce/balsam fir, black spruce, aspen, and paper birch. Common understory species include speckled alder (*Alnus rugosa*), mountain maple (*Acer spicatum*), and pin cherry (*Prunus pensylvanica*) among large shrubs and small trees. Low understory plants include Canada yew (*Taxus canadensis*), red raspberry (*Rubus idaeus* var. *strigosus*), blueberries (*Vaccinium* spp.), and hobblebush (Frank et al. 1980).

- *Eastern White Pine*: Eastern white pine is pure or usually predominant. We include red pine (*Pinus resinosa*) which has a spotty distribution throughout New England on sandy, gravelly or sandy loam soils, and white pine/hemlock, a common subtype in central and southern New England, where it occupies a range of soil types in cool locations such as ravines and north slopes (in the southern parts of its range). These other pine types are included primarily because they support similar wildlife communities.

Eastern white pine frequently occurs in pure stands; common New England associates on light soils are pitch pine (*P. rigida*), gray birch (*Betula populifolia*), quaking and bigtooth aspen, red maple, and white oak (*Quercus alba*). On heavier soils, paper birch, sweet birch, yellow birch, white ash, black cherry, northern red oak, sugar maple, hemlock, red spruce, and northern white cedar are associated in New England, but none are characteristic. The type is widespread in central New England from sea level to an elevation of 2,500 feet (760 m). This type occurs over a wide range of conditions and sites; establishment is often easier on poor sites because hardwood competition is less. Once established on better sites, white pine will usually grow faster than hardwoods.

White pine commonly pioneers on abandoned agricultural land in New England. The type seldom succeeds itself, but on dry sandy soils it may persist a long time and even approach permanence. On heavier soils, white pine is usually succeeded by northern hardwoods, white pine/hemlock, or white oak.

Eastern white pine is a major component of two other New England forest cover types — white pine/northern red oak/red maple, and white pine/hemlock — and occurs in various proportions in other types throughout the region.

In pure or almost pure white pine stands, the understory is composed primarily of ericaceous shrubs such as blueberries, huckleberries (*Gaylussacia* spp.), azaleas

(*Azalea* spp.), and mountain-laurel. In New England common ladyslipper (*Cypripedium* spp.) is common on light soils and highbush blueberry (*V. corymbosum*) on wetter sites (Wendel 1980).

- *Red Spruce/Balsam Fir*: The type may consist of red spruce and balsam fir or together they may predominate in a mixture of associates — the composition varies by site and disturbance history. We include here the northern white-cedar type and associates, which are commonly associated in northern New England. This is the northern New England type, occupying moderately to poorly drained flats, but not swamps. Associates are red maple, paper and yellow birch, and aspens, primarily but also white pine, hemlock, and occasionally black spruce and tamarack (*Larix laricina*).

The type occurs near sea level in eastern Maine, from an elevation of 2,400 to 4,500 feet (730 to 1,370 m) in the White Mountains of New Hampshire, from an elevation of 2,500 to 3,800 feet (760 to 1,160 m) in the Green Mountains of Vermont, and occurs on the tops of some of the higher Berkshire Hills in western Massachusetts.

The type occurs on two kinds of sites in New England: (1) poorly drained flats and ridges or benches at lake shores, streams, and swamps and bogs, and (2) well drained to dry, shallow soils on steep, rocky, upper mountain slopes.

Stands are usually very dense; the ground may be essentially devoid of plants except for mosses and fern seedlings of red spruce and balsam fir. Regenerate stands, however, produce a thick growth of blueberry (*V. angustifolium*), creeping snowberry (*Symphoricarpos mollis*), mountain-holly (*Nemopanthus mucronata*), raspberry (*Rubus* spp.), and downy serviceberry (*Amelanchier arborea*), among others (Griffin 1980).

- *Red spruce*: Red spruce is pure or accounts for the majority of the stocking; common associates in northern New England are balsam fir, paper and yellow birch; others include sugar maple, red maple, mountain-ash (*Sorbus americana*), eastern white pine and eastern hemlock. Red spruce occurs near sea level in eastern Maine and from an elevation of 1,500 to 4,500 feet (450 to 1,370 m) inland throughout northern New England on moderately well-drained to poorly drained flats (but not true swamps), and on well-drained slopes, including thinly soiled upper slopes. Red spruce pioneers on abandoned fields and pastures in northern New England, and on these fairly well-drained sites it is usually replaced by shade tolerant hardwoods, especially sugar maple and beech. Red spruce is long-lived; barring major disturbance is very stable, and older stands develop an uneven-aged character even though of even-aged origin. The understory is frequently sparse, or even absent; the ground beneath stands of red spruce is covered with tree litter and patches of short-lived red spruce seedlings.

field red spruce contain a ground cover of bunchberry (*Cornus canadensis*) on wet sites and hobblebush on well-drained sites. Regenerated stands usually produce raspberries in abundance (Blum 1980).

- **Eastern Hemlock:** Eastern hemlock is pure or pre-dominant over any associate, but associates are numerous; these commonly include beech, sugar maple, yellow birch, red maple, black cherry, white pine, northern red oak, white oak, sweet birch, and in northern New England, paper birch, balsam, fir, and red spruce. In northern New England the type prefers cool locations such as moist ravines and north slopes; in the northern parts of its New England distribution, warmer drier sites are tolerated. Occurs from sea level to an elevation of 4000 feet (915 m) in New England.

Eastern hemlock is very shade-tolerant. Its long life span and ability to respond to release after almost two centuries of suppression have allowed the type to persist; selective logging, and the fires that followed, greatly reduced the occurrence of this shallow-rooted climax species. Under mature stands, understory development is sparse; openings to admit light commonly produce red maple, hobblebush, mapleleaf viburnum, and others. False lily-of-the-valley (*Maianthemum canadense*) is probably the most common herb (Wiant 1980).

Terrestrial, Wetland, and Other Nonforest Habitat Types

The matrix of wildlife species occurrence in nonforest habitats includes entries for terrestrial, wetland, and other habitat types. Many wildlife species that occur in forest habitats either prefer or require one or more nonforest habitats, usually for breeding. For example, northern American toads (*Bufo a. americanus*) and mole salamanders (*Ambystoma* spp.) occur throughout many upland areas, except for brief, critical breeding periods in wetlands.

The nonforest habitat types are:

Terrestrial:

Upland Fields

Cultivated — tilled agricultural cropland

Grass — hayfields, etc.

Forb — broadleaved herbaceous cover, e.g., goldenrod (*Solidago*), sensitive fern (*Onoclea*), etc.

Old fields — abandoned agricultural fields reverting to forest, characterized by grasses, shrubs, small trees

Pastures — usually too wet or rocky for cultivation

Savanna — grasslands with shrubs and widely, irregularly scattered trees, resulting from either soil-moisture regimes or disturbances such as fire or grazing

Orchards — fruit trees, grassy ground cover

Krummholz zone — the transition zone from subalpine forest to alpine tundra characterized by dwarfed, deformed, wind-sheared trees

Alpine zone — elevated slopes above timberline characterized by low, shrubby, slow-growing woody plants and a ground cover of boreal lichens, sedges, and grasses.

- **Wetland/Deep Water:** In general, wetlands are lands where saturation with water largely determines the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The dominant plants are hydrophytes. The single feature that most wetlands share is soil or substrate that is at least periodically saturated or covered by water.

Wetlands are transitional sites between terrestrial and aquatic systems where the water table is usually at or near the surface, or where the land is covered by shallow water.

Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium within which the dominant organisms live, whether or not they are attached to the substrate. As in wetlands, the dominant plants are hydrophytes; however, the water is generally too deep to support emergent vegetation.

Palustrine — non-tidal wetlands dominated by emergent mosses, lichens, persistent emergents, shrubs, or trees (Cowardin et al. 1979).

Sedge meadow — dominated by sedges (*Carex*), cattails (*Typha*) etc.; surface water depths to 6 inches (15 cm) in winter and early spring; soil surface exposed but saturated in summer

Shallow marsh — characterized by persistent emergent vegetation and water depths to 1.5 feet (0.5 m)

Deep marsh — characterized by emergent and floating-leaved plants and water depths to 6 feet (2 m)

Shrub swamp — dominated by woody vegetation less than 20 feet (6 m) tall, soil seasonally or permanently flooded to a depth of 1 foot (30 cm)

Bog — characterized by peat accumulation due to cold, acidic conditions; (usually) a floating mat of vegetation; generally sundew (*Drosera*) and pitcher plant (*Sarracenia*) are common.

Pond — permanent palustrine water body, characterized by emergent and/or floating-leaved plants, up to 20 acres (8 ha) in size

Lacustrine — deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage; and (3) total area exceeds 4 ha (10 acres)

Lake — characterized by water depth of 6.5 feet (2 m)

Riverine — wetlands and deepwater habitats contained within a channel through which the water flows

Stream — intermittent or permanent up to 30 cubic feet (0.0283 m³) per second, at high flow

River — at least 30 cubic feet (0.0283 m³) per second at low flow

Riparian Zone — stream and river banks and associated vegetation

Estuarine — deepwater tidal habitats and adjacent tidal wetlands that are usually semienlosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Marine habitats

Coastal beaches and rocks

Bay, ocean

• Other:

Stable banks - excavated sand on gravel banks or naturally cut stream banks topped by an overhanging grassy top

Ledge, cliff

Cave

Structure, building

Derelict building, debris — abandoned building, etc.

Species Activities/Season of Occurrence

Habitat utilization by species is rated separately for life history activities and seasons as follows for birds and mammals:

B — Breeding season (for mammals, refers to the period when young are born and being nurtured).

BF — Breeding season, feeding

W — Winter

WF — Winter feeding

For amphibians and reptiles, habitat use is shown for breeding (B) and nonbreeding (NB) seasons only, because, with few exceptions, they are inactive during winter, and overwinter underground or in bottom sediments, etc.

Consult the species accounts for the time periods of these activities.

Habitat Suitability

The suitability (quality) of each community type for given species was based on ratings by the experts and knowledge, and on our field experience. Although they are subjective, they represent the best estimate currently available. On the matrix, the light shading indicates utilized habitat, and the dark shading with bull indicates preferred habitat.

Species Accounts/Distribution Maps

Life history details are summarized in accounts for each species. We assembled this information from the available literature, expert reviews, and continuing field research. Distribution maps for each species have been compiled from numerous sources. Approximate continuous range in New England is shown and may include areas where a species has not been found, but is presumed to occur where its required habitat components are present.

Life history information is arranged as follows: Range, Relative Abundance in New England, Habitat, Special Habitat Requirements, Reproductive Habits (conclusions vary with classes of vertebrates), Territory, Home Range, Sample Densities, Foraging Habits, Economic Status, Comments, and Key References.

The range description includes the animal's distribution throughout the United States and Canada.

The relative abundance indicated in each species account is an approximation of the species occurrence in New England. Included in the habitat section are details of the requirements for breeding or hibernation, where applicable. If specific habitat components are required of a species for its regular occurrence, these are listed under special habitat requirements. Reproductive, home range, sample densities, and foraging information is taken from studies conducted in New England when such references were available. Where information from

states outside the region is included, the locality of the research is noted in the text. The comments section includes additional information to acquaint the user with each species.

Frequently, life history information was unavailable; further research is needed to fill these gaps. Key references are key life history references among those that we consulted; they are the most complete general references available, but not necessarily the most recent.

The compilation of natural history and habitat information for the inland (nonmarine) wildlife of New England can aid foresters and forest wildlife biologists in assessing the potential effects of proposed habitat management practices on wildlife species. It would also aid land managers in developing and evaluating resource management planning alternatives. All inland species are presented in terms of practical habitat classification schemes for forested and nonforested habitats, so that management objectives can be set and evaluated and costs assessed.

Application of Information

The information can be used for considering the potential responses of amphibians, reptiles, birds, and mammals to habitat alterations through forest management in New England. We stress the word *potential*. There is no substitute for sound field work and judgment in assessing the impacts of a specific project or proposed management action. From a research standpoint, the habitat associations provided here are essentially a set of hypotheses that can and should be tested further. The information in this publication is most useful for land management and project planning; the larger the unit considered, the more accurately the species occurrence can be predicted. Large areas will likely contain more of the special habitat requirements, more edges due to the interspersed habitats, and more successional stages, hence more species. Conversely, the smaller (more site-specific) an area, the less accurate will be assumptions or predictions of species occurrence, and the greater the need for biological experience and detailed field work.

Users of this publication are urged to identify the species applicable to their area of interest or responsibility. These species can be checked in the local occurrence column on the matrix.

If questions on individual species remain unanswered, consult the references in the species accounts.

A list of species potentially affected by a given project can be prepared by looking down the columns of habitat descriptions under consideration, and, at each entry encountered, checking to see whether that species has a special habitat requirement listed. If so, and if the proposed project site does not contain that requirement, the species likely will not occur there. This two-stage examination of species not occurring in the project area and of species whose special needs do not occur on the site, will facilitate the development of a list of species inhabiting the site. Such a process implies familiarity with the site — it should be visited, and its features — streams, marshes, snags, and so on — noted before a list of species is prepared.

Last, each species response to the proposed alternative can be identified by noting whether it will be posi-

tively or negatively affected by a project. If the nature of the resulting change in vegetation is known, examination of the size class or successional entries in a given forest type will at least reveal those species that are associated with earlier or later stages. If the direction of habitat alteration is known, a good judgment can be made on the likely effects on wildlife species.

Obviously, if threatened or endangered species are likely to be affected by a project, consultation with the Regional Endangered Species Coordinator, Fish and Wildlife Service, U.S. Department of Interior, is required.

Accuracy of Information

This publication must be considered the beginning effort to assemble the natural history and habitat associations to enable sound management of New England wildlife. The data base needs to be expanded to other nonforested habitats, and entries need to be field checked to improve accuracy. The limitations of the information point up some cautions:

- This publication is not a substitute for professional field work, nor for thoroughly checking each site proposed for management. At the very least, managers need field information on the special habitat requirements present or lacking on each site proposed for management.
- This publication lists the species potentially occurring in a given habitat. More are listed than will likely occur — the smaller the site, the fewer the actual species that will occur of those potentially able to occur. Factors other than habitat features affect a given species occurrence on a given area. This effect diminishes with increasing area of consideration. Still, several site visits will be required to determine whether a given species actually occurs on a given site.
- No information is included on habitat size. The best clue to help determine whether a given species will occur, after checking whether its special habitat requirements are present, is to compare its territory or home-range size with that of the proposed project. No detailed information, therefore, is provided here on how many of a given species will occur on a given area. Merely dividing the project area by the territory/home range area of a species is not recommended, because not all parts of a habitat patch will be occupied, and density will be overestimated. For an elaboration on these cautionary notes, see Verner and Boss (1980). We have provided sample densities when such information was reported. Note localities when consulting these entries.

LITERATURE CITED

- Bailey, R.G. Ecoregions of the United States. Misc. Publ. 1391. Washington, DC: U.S. Department of Agriculture; 1980. 77 p.
- Baldwin, Henry I.; Ward, W. W. White pine-northern red oak-red maple. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 27-28.
- Berglund, John V. Sugar maple-beech-yellow birch. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 31.
- Blum, Barton M. Red spruce. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 19.
- Brinkman, K. A.; Roe, E. I. Quaking aspen: silvics and management in the Lake States. Agric. Handb. 486. Washington, DC: U.S. Department of Agriculture; 1975. 52 p.
- Cowardin, L. M.; Carter, V.; Golet, F. C.; LaRoe, E. T. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1979. 103 p.
- Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980. 148 p.
- Fernald, M. L. Gray's Manual of Botany. 8th ed. New York: D. Van Nostrand Co.; 1950. 1632 p.
- Frank, Robert M.; Majcen, Zoran; Gagnon, Gilles. Balsam fir. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 10-11.
- Griffin, Ralph H. Red spruce-balsam fir. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 19-20.
- Kuchler, A. W. Potential natural vegetation of the conterminous United States. Spec. Publ. 36. New York: American Geographical Society; 1964.
- Little, Elbert L., Jr. Checklist of United States Trees (Native and Naturalized). Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture; 1979. 375 p.
- Powell, Douglas S.; Erdmann, Gayne G. Red maple. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 34-35.
- Safford, L. O. Paper birch. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 18.
- Thomas, Jack W. Wildlife habitats in managed forests, the Blue Mountains of Oregon and Washington. Agric. Handb. 553. Washington, DC: U.S. Department of Agriculture; 1979. 512 p.
- Trimble, G. R., Jr. Northern red oak. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 43-44.
- Verner, J.; Boss, A. S., tech. eds. California wildlife and their habitats: western Sierra Nevada. Gen. Tech. Rep. PSW-37. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1980. 439 p.
- Wendel, George W. Eastern white pine. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 25-26.
- Westveld, Marinus. Ecology and silviculture of spruce-fir forests of eastern North America. Journal of Forestry. 51: 422-430; 1953.
- Wiant, Harry V., Jr. Eastern hemlock. *In* Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 1980: 27.

AMPHIBIANS AND REPTILES

This section provides a compilation of natural histories, distributions, and habitat associations for the 26 amphibians and 30 reptiles occurring in New England. The distributions of several species are not well known in New England—maps need to be up-dated periodically. Nomenclature follows that of Collins and others (1982): *Standard Common and Current Scientific Names for North American Amphibians and Reptiles*.

We have included the mudpuppy (*Necturus m. maculosus*) and red-eared slider (*Pseudemys scripta elegans*), introduced species that have established populations in parts of the region. We have omitted the eastern mud turtle (*Kinosternon s. subrubrum*) because Connecticut individuals are believed to have been released

and no breeding populations are known to exist. We have also omitted the rough green snake (*Opheodrys aestivus*)—although two records exist for Connecticut, no breeding populations are known.

Species are listed in phylogenetic order. Measurement units here are as reported in the original work. When the original work used English units, metric equivalents have been supplied. Variations in development and hatching times for a species may be attributed to genetic and environmental factors. Although key references are given for each species, the species accounts point up many gaps in our knowledge of amphibians and reptiles.

Species and Subspecies

data	
ecturidae	
Mudpuppy (<i>Necturus m. maculosus</i>)	39
mbystomatidae	
Marbled Salamander (<i>Ambystoma opacum</i>)	40
Jefferson Salamander (<i>Ambystoma jeffersonianum</i>)	41
Silvery Salamander (<i>Ambystoma platineum</i>)	43
Blue-spotted Salamander (<i>Ambystoma laterale</i>)	44
Tremblay's Salamander (<i>Ambystoma tremblayi</i>)	45
Spotted Salamander (<i>Ambystoma maculatum</i>)	46
alamandridae	
Red-spotted Newt (<i>Notophthalmus v. viridescens</i>)	48
lethodontidae	
Northern Dusky Salamander (<i>Desmognathus f. fuscus</i>)	50
Mountain Dusky Salamander (<i>Desmognathus ochrophaeus</i>)	52
Redback Salamander (<i>Plethodon cinereus</i>)	53
Slimy Salamander (<i>Plethodon g. glutinosus</i>)	55
Four-toed Salamander (<i>Hemidactylium scutatum</i>)	56
Northern Spring Salamander (<i>Gyrinophilus p. porphyriticus</i>)	57
Northern Two-lined Salamander (<i>Eurycea b. bislineata</i>)	58
ra	
elobatidae	
Eastern Spadefoot (<i>Scaphiopus h. holbrookii</i>)	59
ufonidae	
Eastern American Toad (<i>Bufo a. americanus</i>)	60
Fowler's Toad (<i>Bufo woodhousii fowleri</i>)	61
ylidae	
Northern Spring Peeper (<i>Hyla c. crucifer</i>)	62
Gray Treefrog (<i>Hyla versicolor</i>)	63
anidae	
Bullfrog (<i>Rana catesbeiana</i>)	64
Green Frog (<i>Rana clamitans melanota</i>)	65
Mink Frog (<i>Rana septentrionalis</i>)	66
Wood Frog (<i>Rana sylvatica</i>)	67
Northern Leopard Frog (<i>Rana pipiens</i>)	68
Pickerel Frog (<i>Rana palustris</i>)	69
udines	
helydridae	
Common Snapping Turtle (<i>Chelydra s. serpentina</i>)	70
lnosternidae	
Stinkpot (<i>Sternotherus odoratus</i>)	71

Emydidae	
Spotted Turtle (<i>Clemmys guttata</i>)	72
Bog Turtle (<i>Clemmys muhlenbergii</i>)	73
Wood Turtle (<i>Clemmys insculpta</i>)	75
Eastern Box Turtle (<i>Terrapene c. carolina</i>)	77
Map Turtle (<i>Graptemys geographica</i>)	78
Red-eared Slider (<i>Pseudemys scripta elegans</i>)	79
Plymouth Redbelly Turtle (<i>Pseudemys rubriventris bangsi</i>)	80
Eastern Painted Turtle (<i>Chrysemys p. picta</i>)	81
Midland Painted Turtle (<i>Chrysemys picta marginata</i>)	82
Blanding's Turtle (<i>Emydoidea blandingii</i>)	83
Trionychidae	
Eastern Spiny Softshell (<i>Trionyx s. spiniferus</i>)	84
Squamata	
Lacertilia	
Scincidae	
Five-lined Skink (<i>Eumeces fasciatus</i>)	85
Serpentes	
Colubridae	
Northern Water Snake (<i>Nerodia s. sipedon</i>)	86
Northern Brown Snake (<i>Storeria d. dekayi</i>)	87
Northern Redbelly Snake (<i>Storeria o. occipitomaculata</i>)	88
Eastern Garter Snake (<i>Thamnophis s. sirtalis</i>)	89
Maritime Garter Snake (<i>Thamnophis sirtalis pallidula</i>)	90
Eastern Ribbon Snake (<i>Thamnophis s. sauritus</i>)	91
Northern Ribbon Snake (<i>Thamnophis sauritus septentrionalis</i>)	92
Eastern Hognose Snake (<i>Heterodon platyrhinos</i>)	93
Northern Ringneck Snake (<i>Diadophis punctatus edwardsi</i>)	94
Eastern Worm Snake (<i>Carphophis a. amoenus</i>)	95
Northern Black Racer (<i>Coluber c. constrictor</i>)	96
Eastern Smooth Green Snake (<i>Opheodrys v. vernalis</i>)	97
Black Rat Snake (<i>Elaphe o. obsoleta</i>)	98
Eastern Milk Snake (<i>Lampropeltis t. triangulum</i>)	99
Viperidae	
Northern Copperhead (<i>Agkistrodon contortrix mokeson</i>)	100
Timber Rattlesnake (<i>Crotalus horridus</i>)	101

SPECIES OCCURRENCE AND UTILIZATION, BY HABITAT FORESTED

SPECIES	Local occurrence	Seasonal use	Aspen	Paper birch	Northern hardwoods	Red maple	Northern red oak	White pine— Northern red oak— Red maple	Balsam fir	Eastern white pine	Red spruce - Balsam fir	Red spruce	Eastern hemlock
		B W	S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Marbled Salamander <i>Ambystoma opacum</i>	Woodland ponds or swamps for breeding	B W											
Jefferson Salamander <i>Ambystoma jeffersonianum</i>	Temporary pools for breeding	B W											
Silvery Salamander <i>Ambystoma platyneuron</i>	Temporary pools for breeding	B W											
Blue-spotted Salamander <i>Ambystoma laterale</i>	Ponds or semi-permanent water for breeding	B W											
Tremblay's Salamander <i>Ambystoma tremblayi</i>	Woodland ponds for breeding	B W											
Spotted Salamander <i>Ambystoma maculatum</i>	Mesic woods, semi-permanent water (pH 7.9) for breeding	B W											
Red-spotted Newt <i>Notophthalmus v. viridescens</i>	Water with aquatic vegetation for adult newt	B W											
Northern Dusky Salamander <i>Desmognathus f. fuscus</i>	Permanent woodland streams or seeps	B W											
Mountain Dusky Salamander <i>Desmognathus ochropneustes</i>	Woodland seeps, springs or streams	B W											
Redback Salamander <i>Plethodon cinereus</i>	Logs, stumps, rocks, etc.	B W											
Slimy Salamander <i>Plethodon glutinosus</i>	Rock outcroppings, logs within wooded areas	B W											

SPECIES	Local occurrence	Special habitat needs	Seasonal use												Aspen	Paper birch	Northern hardwoods	Red maple	Northern red oak	White pine— Northern red oak— Red maple	Balsam fir	Eastern white pine	Red spruce -Balsam fir	Red spruce	Eastern hemlock																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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Four-toed Salamander <i>Hemidactylum scutatum</i>		Wet woodlands																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												

SPECIES	Special habitat needs	Local occurrence
Common Snapping Turtle <i>Chelydra s. serpentina</i>	Aquatic habitat, sandy or gravelly soil or banks	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Bog Turtle <i>Clemmys muhlenbergii</i>	Wet meadow in full sun	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Wood Turtle <i>Clemmys insculpta</i>	Wooded river or stream banks	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Eastern Box Turtle <i>Terrapene c. carolina</i>	Old fields, clearings, ecotones with sandy soils	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Eastern Painted Turtle <i>Chrysemys p. picta</i>	Ponds with projecting or floating logs	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Five-lined Skink <i>Eumeces fasciatus</i>	Open woods with logs and slash piles	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Northern Water Snake <i>Nerodia s. sipedon</i>	Branches, logs overhanging water or boulders of dams and causeways in reservoirs	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Northern Brown Snake <i>Storeria d. dekayi</i>		<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Northern Redbelly Snake <i>Storeria o. occipitomaculata</i>		<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Eastern Garter Snake <i>Thamnophis s. sirtalis</i>		<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>
Eastern Ribbon Snake <i>Thamnophis s. saurilis</i>	Mesic woodlands with aquatic habitat	<div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>W</div> </div>

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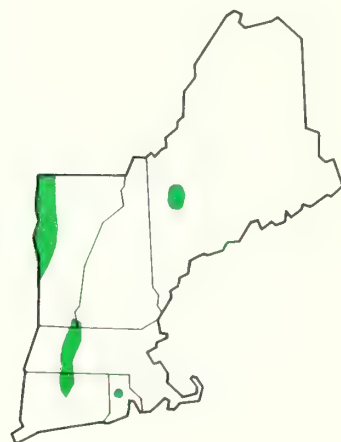
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mudpuppy

Ambystoma m. maculosus)



RANGE: St. Lawrence River w. to se. Manitoba, s. to e. Kansas and n. Alabama and through c. Pennsylvania to New York and the Champlain Valley. Absent from the Adirondacks. Introduced in parts of New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Entirely aquatic. Clear or muddy waters of lakes, rivers, ditches, and large streams. One individual found at 90 feet (27.4 m) in Lake Michigan (Behler and Gillingham 1979:283). Often found in submerged log piles around the bases of bridge pilings in larger rivers and around obstructions in streams (Shoop and Gunning 1967).

SPECIAL HABITAT REQUIREMENTS: Moving water.

AGE/SIZE AT SEXUAL MATURITY: At 5 years and at 8 inches (20.3 cm) total length (Bishop 1947:43). Retains external gills as an adult.

FEEDING PERIOD: Autumn (Bishop 1947:42).

EGG DEPOSITION: May and June of the year following hatching. Reproduces in flowing water (Oliver 1955:211). Prefers water depths of at least 3 feet (0.9 m) and bottoms with weeds and rocks to provide nesting cover. Nest sites are often under large rock slabs in water depths of 6 to 8 inches (15 to 20 cm) in New York (Stewart 1961:68).

EGGS/MASS: 18 to 180 eggs (average 60 to 100) in water beneath objects, attached singly by stalks (Bishop 1947:26).

TIME TO HATCHING: 38 to 63 days, female guards eggs (Bishop 1941:27).

HOME RANGE/MOVEMENT: Displacement of individuals in Louisiana suggests homing ability; occupy restricted areas throughout the year (Shoop and Gunning 1967).

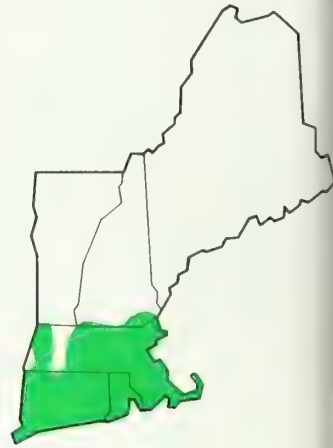
FOOD HABITS/PREFERENCES: In New York, aquatic insects were 30 percent of the diet by weight, particularly nymphs and larval forms, crustaceans 33 percent, small fish 13 percent, also mollusks, spawn, other amphibians, worms, leeches, and plants (Hamilton 1932). Most food captured at night along the bottom.

COMMENTS: The mudpuppy is chiefly nocturnal, bottom dwelling, and active through the winter, when it moves to deeper water. This species was first found in the Connecticut River in Massachusetts in 1931 where laboratory specimens had been released from Amherst College (Warfel 1936). The Maine population also originated from released individuals; however, the Rhode Island population origin is unknown but is presumed to be introduced (Vinegar and Friedman 1967).

KEY REFERENCES: Bishop 1947, Logier 1952.

Marbled Salamander

(*Ambystoma opacum*)



RANGE: New Hampshire and c. Massachusetts, c. Pennsylvania to s. Illinois, s. Missouri to e. Texas. Throughout the Eastern United States except s. Louisiana and Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Sandy and gravelly areas of mixed deciduous woodlands, especially oak-maple and oak-hickory (Minton 1972:46), trap rock slopes (M. Klemens, personal communication). During breeding season, found in low areas around ponds, swamps, and quiet streams. Inhabits somewhat drier areas than other species of *Ambystoma*. During the summer usually found under logs and rocks. Found at 900 feet (274 m) above sea level in Connecticut (Babbitt 1937). Larvae usually found in temporary water throughout the winter. Probably hibernates in deep burrows.

SPECIAL HABITAT REQUIREMENTS: Ponds or swamps in wooded areas for breeding.

AGE/SIZE AT SEXUAL MATURITY: 15 to 18 months.

BREEDING PERIOD: During the fall, adults migrate to breeding areas (September in northern parts of range).

EGG DEPOSITION: September to early October in northern parts of range (Bishop 1941:138). Temperature taken at the nest sites in both New Jersey and South Carolina ranged from 11-15°C (52-59°F), (Anderson and Williamson 1973).

NO. EGGS/MASS: 50 to 232 (average 100) eggs laid singly in shallow depressions beneath surface materials (Bishop 1941:142). Eggs laid in dry beds of temporary ponds and streams or on land, or at the edge of ponds or

swamps, where they will be washed into the water to hatch.

TIME TO HATCHING: 15 to 207 days; female forms a nest site and may brood eggs (Oliver 1955:234).

EGGS HATCH: Usually in fall or early winter when submerged but without rain will hatch in spring. Anderson (1972) found a wide range of temperature tolerance — 3-14°C (37 — 75°F) — for egg development.

LARVAL PERIOD: Larvae overwinter with little growth until spring, and transform to terrestrial form in late May to June (Noble and Brady 1933). A higher temperature and abundant food supply will hasten metamorphosis (Stewart 1956b). The larval period was 135 days in New Jersey (Hassinger et al. 1970).

HOME RANGE/MOVEMENT: Adults migrate an average of 194 m from breeding sites to summer range in Indiana (Williams 1973, cited in Semlitsch 1980b:320).

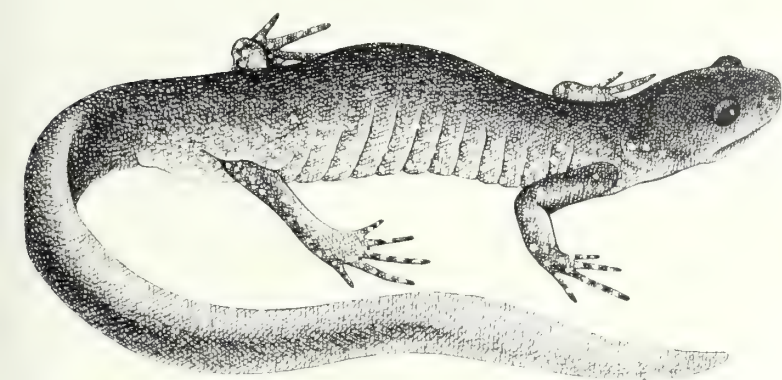
FOOD HABITS/PREFERENCES: Arthropods, including adults and larval insects and crustaceans. Also takes earthworms and mollusks. Marbled salamander larvae eat small aquatic insects, crustaceans, and other small invertebrates and are cannibalistic (Minton 1972:47). Larvae rise in the water column to feed (T. Tynning, personal communication).

COMMENTS: Terrestrial and nocturnal, often using runways of other animals or tunnels through loose soil. Young larvae are aquatic and primarily nocturnal.

KEY REFERENCES: Anderson 1967b, Hassinger et al. 1970, Lazell 1979.

Jefferson Salamander

(*Ambystoma jeffersonianum*)



NOTE: See COMMENTS section.

RANGE: Western New England to wc. Indiana, c. Kentucky to w. Virginia and n. to n. New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to rare.

HABITAT: Terrestrial, found in undisturbed damp, shady deciduous or mixed woods, bottomlands, swamps, meadows, moist pastures, or lakeshores. Hides beneath leaf litter, under stones or in decomposing logs and stumps. Cleared strips create a barrier for dispersal (Pough and Wilson 1976). Upland hardwood forests on isolated limestone areas northwest of the Great Swamp in New Jersey (Anderson and Giacosis 1967). In Connecticut, members of the *Ambystoma jeffersonianum* complex are more abundant and widespread in upland areas of the Connecticut River Valley (M. Klemens, personal communication) and documented within shale raffles in Connecticut (Babbitt 1937). Hibernates on land in winter months, usually near breeding waters. Have been found within rotten logs (Blanchard 1933b).

SPECIAL HABITAT REQUIREMENTS: Requires temporary pools for breeding period. Egg mortality exceeded 60 percent in pools more acid than pH 5 in Tompkin's County, New York (Pough 1976).

AGE/SIZE AT SEXUAL MATURITY: Females at 21 months (Bishop 1941:102), snout to vent length 70 to 75 mm in males, 75 to 80 mm in females (Minton 1954). Juveniles probably enter the breeding population at 2 to 3 years of age (Wilson 1976, cited in Thompson et al. 1980:119).

BREEDING PERIOD: February to April, migrates to ponds and vernal pools for spawning (Brandon 1961). Breeds earlier than *A. maculatum* in central Pennsylvania (Gatz 1971).

EGG DEPOSITION: February to April, often beneath ice. Will tolerate pH of 4 to 8, with best hatching success at 5 to 6 pH range (Pough and Wilson 1976). Isolated upland pools bordered by shrubs and surrounded by forest were primary breeding sites in Maryland (Thompson et al. 1980).

NO. EGGS/MASS: 107 to 286 eggs (Oliver 1955:234). Many variations of egg deposition, laid singly or in small cylindrical masses of 1 to 35 eggs each, in water attached to twigs or plants or under rocks. Egg masses average 16 eggs per mass (Bishop 1941:94).

TIME TO HATCHING: 13 to 45 days (Bishop 1947:135, Oliver 1955:234).

LARVAL PERIOD: 56 to 125 days (Bishop 1941:99). Found overwintering in Nova Scotia (Bleakney 1952).

Jefferson Salamander (Continued)

(*Ambystoma jeffersonianum*)

HOME RANGE/MOVEMENT: Adults migrated an average of 252 m from breeding ponds to summer range in Indiana. Newly metamorphosized individuals moved an average 92 m from the ponds (Williams 1973, cited in Semlitsch 1980b:320). In hardwood forest of northern Kentucky, adults moved an average of 250 m from ponds in a series of 6 to 8 moves in 45 days (Douglas and Monroe 1981).

FOOD HABITS/PREFERENCES: Small invertebrates, including worms, millipedes, spiders, insects, and aquatic crustaceans. Feeds on most animal life that it can capture.

COMMENTS: Before 1964, almost all references to specimens in the *Ambystoma jeffersonianum* complex (including *A. jeffersonianum*, *A. laterale*, *A. tremblayi*, and *A. platineum*) were reported as *A. jeffersonianum* (Uzzell 1964). Many papers have since dealt with the ge-

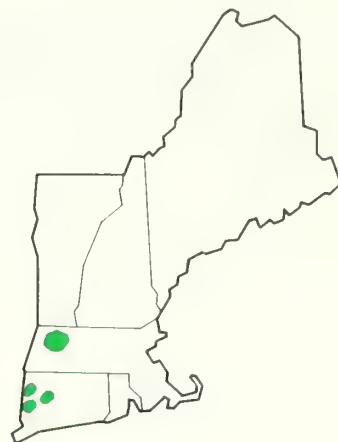
netics and taxonomy of this complex. This ongoing taxonomic revision has resulted in many apparently erroneous locality records. *Ambystoma jeffersonianum* is currently believed not to occur east of the Connecticut River Valley (at least in central and northern New Hampshire) and all museum specimens from this area identified as *A. jeffersonianum* have been found to refer to the diploid blue-spotted salamander (*A. laterale*) or the triploid Tremblay's salamander (*A. tremblayi*) (Thomas French personal communication).

The Jefferson salamander may occur throughout the Connecticut River Valley in southwestern New Hampshire. The only one verified record in New Hampshire is Winchester, Cheshire County, in May 1984 (NHNHI unpublished data).

KEY REFERENCES: Anderson and Giacosis 1967, Logie 1952, Pough and Wilson 1976, Uzzell 1967a.

Silvery Salamander

(*Ambystoma platineum*)



RANGE: Occurs with *A. jeffersonianum*; however, range is mainly restricted to areas north of the Wisconsin glacial moraine where ranges of *A. jeffersonianum* and *A. laterale* meet or overlap. Central Indiana e. to n. New Jersey and w. Massachusetts.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Found with *A. jeffersonianum* in upland hardwood forests in Sussex County, New Jersey (Anderson and Giacosis 1967).

SPECIAL HABITAT REQUIREMENTS: See *A. jeffersonianum*.

AGE/SIZE AT SEXUAL MATURITY: Unreported.

BREEDING PERIOD: March to April (Behler and King 1979:296).

EGG DEPOSITION: Unreported.

DEVELOPMENT: Typically 15 to 20 eggs per mass, in cylindrical masses attached to submerged twigs and grass stems. Rarely if ever attached to pond bottom debris (Uzzell 1967c:49.1).

DIURNAL RANGE/MOVEMENT: Unreported.

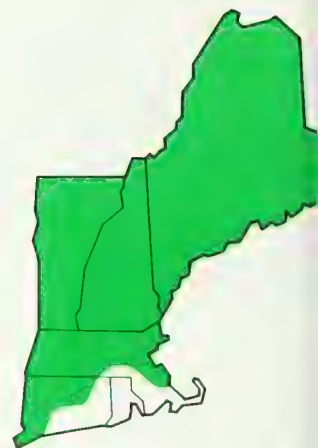
DIET/HABITS/PREFERENCES: Unreported.

COMMENTS: A hybrid of Jefferson and blue-spotted salamanders with three sets of chromosomes (two sets from Jefferson and one from blue-spotted). Most are female, only one male has been recorded (Smith 1978:88). Genetic material is not contributed by male Jefferson; the sperm only stimulates egg production (Uzzell 1964). *A. jeffersonianum* and *A. laterale* probably developed from a common ancestor that was reproductively isolated by the Wisconsin glaciation. As the glacier retreated and the two species mixed, hybridization occurred (Uzzell 1964). All four species of the complex have been found to occur sympatrically in a few areas: *A. laterale* and *A. tremblayi* are generally more northern; *A. jeffersonianum* and *A. platineum* are generally more southern in the range of the complex (Austin and Bogart 1982).

KEY REFERENCES: Smith 1978; Uzzell 1964, 1967.

Blue-spotted Salamander

(*Ambystoma laterale*)



NOTE: See COMMENTS for information for Jefferson salamander

RANGE: Southeastern Quebec and the n. shore of the Gulf of St. Lawrence to James Bay and the s. end of Lake Winnipeg, s. to n. Illinois and Indiana, n. New York and New England. Disjunct colonies in New Jersey, Long Island, Iowa, and Labrador.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare; threatened in southern portion of range.

HABITAT: Wooded, swampy or moist areas (Minton 1954). Occasionally in overgrown pastures. Sometimes occurs where soil is sandy, and may be found under logs or other forest debris (in hardwood forests in the remnants of glacial Lake Passaic in New Jersey) (Anderson and Giacosis 1967). Occurs in a wide range of elevations (in western Connecticut) and along the Connecticut River floodplain (M. Klemens, personal communication).

SPECIAL HABITAT REQUIREMENTS: Ponds or semi-permanent water for breeding.

AGE/SIZE AT SEXUAL MATURITY: Snout to vent length of 47 to 55 mm in Indiana (Minton 1954).

BREEDING PERIOD: During early spring rains when night temperatures are above freezing (Lazell 1968).

EGG DEPOSITION: March to early April. Eggs laid on the bottoms of temporary shallow forest ponds, roadside drainage ditches, temporary pasture ponds, kettle holes (Landre 1980), attached to litter or in bottom detritus (Stille 1954), and twigs (Uzzell 1976b:48.1).

NO. EGGS/MASS: Varies greatly: 199 to 247 eggs (Uzzell 1964); 82 to 489 (Minton 1972:36); 6 to 10 eggs per mass (Landre 1980); often laid singly (Uzzell 1967b).

TIME TO HATCHING: About 1 month (Smith 1961:28).

LARVAL PERIOD: Extending to late June or mid-August (Smith 1961:28).

HOME RANGE/MOVEMENT: Unreported.

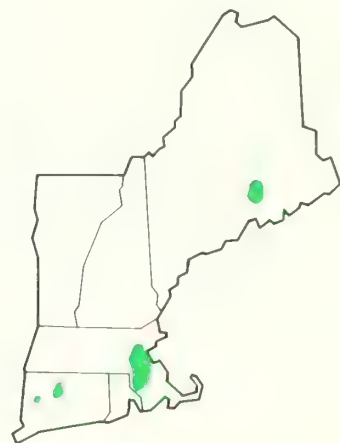
FOOD HABITS/PREFERENCES: Arthropods, annelids, and centipedes.

COMMENTS: Acid precipitation and habitat loss are major threats to this species in the Northeast.

KEY REFERENCES: Anderson and Giacosis 1967; Blewett 1957; Landre 1980; Uzzell 1964, 1967b.

Tremblay's Salamander

(*Ambystoma tremblayi*)



NOTE: See COMMENTS section for Jefferson salamander.

RANGE: Disjunct colonies in New Brunswick, Ottawa River drainage, e. Massachusetts, New Jersey, nw. Ohio, Indiana and Michigan, and n. Wisconsin. (Connecticut record dependent on interpretation of electrophoretic data.)

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare

HABITAT: Deciduous forests surrounding small ponds or lakes (Minton 1972:37). Have been found under logs.

SPECIAL HABITAT REQUIREMENTS: Woodland ponds for breeding.

AGE/SIZE AT SEXUAL MATURITY: Unreported.

BREEDING PERIOD: March in Indiana (Minton 1972:38).

EGG DEPOSITION: April (Uzzell 1964).

NO. EGGS/MASS: 135 to 162 eggs (Uzzell 1964), laid in groups of two, three, or four, sometimes singly, in small clusters at pond bottoms or attached to submerged sticks (Uzzell 1967a:50.1).

LARVAL PERIOD: Transform in 95 to 101 days (Uzzell 1964). Larval period shortens as eggs are deposited later in the spring.

TIME TO HATCHING: Unreported.

HOME RANGE/MOVEMENT: Unreported.

FOOD HABITS/PREFERENCES: Thought to be similar to *A. laterale*.

COMMENTS: Triploid of hybrid origin from *A. laterale* and *A. jeffersonianum*, similar to *A. laterale*, from which it receives two sets of chromosomes, one set from *A. jeffersonianum*. Female population only (gynogenetic reproduction) depends on males of *A. laterale* to stimulate egg development (Uzzell 1964). The spermatophore of *A. laterale* is picked up, but the sperm does not penetrate the egg.

KEY REFERENCES: Minton 1972; Uzzell 1964, 1967a.

Spotted Salamander

(*Ambystoma maculatum*)



RANGE: Nova Scotia and the Gaspé Peninsula to s. Ontario, s. through Wisconsin, s. Illinois excluding prairie regions, to e. Kansas and Texas, and through the Eastern United States, except Florida, the Delmarva Peninsula, and s. New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common though populations declining, probably due to acid precipitation.

HABITAT: Fossorial; found in moist woods, streambanks, beneath stones, logs, boards. Prefers deciduous or mixed woods on rocky hillsides and shallow woodland ponds or marshy pools that hold water through the summer for breeding. Usually does not inhabit ponds containing fish (Anderson 1967a). Terrestrial hibernator. In summer often wanders far from water source. Found in low oak-hickory forests with creeks and nearby swamps in Illinois (Cagle 1942, cited in Smith 1961:30). Have been found in the pitch-pine-scrub oak community of the Albany Pine Bush (Stewart and Rossi 1981), dense oak forests in Rhode Island.

SPECIAL HABITAT REQUIREMENTS: Mesic woods with semi-permanent water for breeding. Eggs tolerate pH range of 6 to 10 with best hatching success at pH 7 to 9 (Pough and Wilson 1976). High embryonic mortality occurred in temporary pools with pH below 6.0 in New York (Pough 1976).

AGE/SIZE AT SEXUAL MATURITY: During second year. Males may mature 1 year earlier than females (Wacasey 1961).

BREEDING PERIOD: March to mid-April. Mass breeding migrations occur in this species: individuals enter and leave breeding ponds using the same track each year and exhibit fidelity to breeding ponds (Shoop 1956 1974). Individuals may not breed in consecutive year (Husting 1965). Breeding migrations occur during steady evening rainstorms.

EGG DEPOSITION: 1 to 6 days after first appearance of adults at ponds (Bishop 1941:114).

NO. EGGS/MASS: 100 to 200 eggs, average of 125, laid in large masses of jelly, sometimes milky, attached to stem about 15 cm (6 inches) under water. Each female lays 1 to 10 masses (average of 2 to 3) of eggs (Wright and Allen 1909). Woodward (1982) reported that females breeding in permanent ponds produced smaller, more numerous eggs than females using temporary ponds.

TIME TO HATCHING: 31 to 54 days (Bishop 1947:145). In cold ($\leq 10^{\circ}\text{C}$) 50°F) spring-fed pond, eggs developed in 60 days in Rhode Island (Whitford and Vinegar 1966). Shoop (1974) reported 8 to 14 days.

LARVAL PERIOD: 61 to 110 days, and as short as 15 to 6 days (Shoop 1974); found overwintering in Nova Scotia (Bleakney 1952) and Rhode Island (Whitford and Vinegar 1966). Transforms July to September.

HOME RANGE/MOVEMENT: Individuals have been found up to a quarter of a mile (400 m) from the nearest breeding site in North Carolina (Gordon 1968). Will travel 91.2 to 182.4 m (300 to 600 feet) from woods to ponds

Spotted Salamander (Continued)

Ambystoma maculatum)

open meadows in New York (M. Stewart, personal communication). Individuals were found to use subterranean permanent burrows as retreats; tagged salamanders that were monitored were found within a 300-cm² area of these burrows. Displaced adults moved up to 500 m to return to breeding ponds in Massachusetts (Shoop 1968). Average migration of 150 m from breeding ponds in Kentucky 6- to 220-m range in thick oak-hickory forest. Linear migration was unaffected by the presence or absence of vegetation or change in the topography (Douglas and Monroe 1981).

FOOD HABITS/PREFERENCES: Earthworms, snails, slugs, insects, spiders, particularly larval and adult beetles

(Wacasey 1961). Larval stage may also eat small fish. Cannibalism by larvae occurs under crowded conditions.

COMMENTS: Nocturnal; travel only on ground surface for migrations to and from breeding pools. Rainfall, snowmelt, or high humidity coupled with air temperature of 10°C (50°F) or more, are necessary for migrations to breeding pools. Numbers may be declining primarily due to over-collection and acid rain.

KEY REFERENCES: Anderson 1967a, Douglas and Monroe 1981, Shoop 1965.

Red-spotted Newt

(*Notophthalmus v. viridescens*)



RANGE: Nova Scotia and Gaspé Peninsula w. to the n. shore of Lake Superior and e. Michigan s. to c. Alabama. nc. Georgia. Absent along coast from se. South Carolina, southward.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Adults found in ponds, particularly water with abundant submerged vegetation, and in weedy areas of lakes, marshes, ditches, backwaters, and pools of shallow slow-moving streams or other unpolluted shallow or semipermanent water. Terrestrial juveniles (efts) live in moist areas on land, typically under damp leaves, under brush piles or logs and stumps, usually in wooded habitats. More common in areas of higher elevation in Connecticut (M. Klemens, personal communication; from sea level to an elevation of 1.6 km on Mt. Marcy in the Adirondacks (M. Stewart, personal observation). Moist beech-maple-hemlock woods in New York (Hurlbert 1969), and oak-pine woods in Massachusetts (Healy 1974). May be seen moving about on wet days in spring and summer. Efts hibernate on land, burrowing under logs and debris, but most adults remain active all winter underwater in pond bottoms or in streams. During winter months often found semiactive in groups of 20 to 40 (Morgan and Grierson 1932).

SPECIAL HABITAT REQUIREMENTS: Water with aquatic vegetation for the adult newt.

AGE/SIZE AT SEXUAL MATURITY: 2 to 8 years (Healy 1974). Aquatic juveniles feed almost year-round and mature in

2 years. The eft feeds only during rainy summer periods and requires more time to reach maturity.

BREEDING PERIOD: Spring (April to June), fall (August to October), sometimes November to December (Hurlbert 1969). Characteristically breed in lakes, ponds, and swamps (Hurlbert 1970).

EGG DEPOSITION: Late March to June.

NO. EGGS/MASS: 200 to 375 eggs (Bishop 1941:64), 1 in water, attached singly to the leaves of aquatic plants.

TIME TO HATCHING: 3 to 5 weeks (Logie 1952:64), temperature dependent.

LARVAL PERIOD: 12 to 16 weeks. Postlarval migration from aquatic to terrestrial habitat occurs from summer through late fall during diurnal rainfall in New York (Hurlbert 1970).

HOME RANGE/MOVEMENT: Approximately 270 m² for eft (juveniles) in an oak-pine woodland in western Massachusetts; maximum daily movement was 13 m (Healy 1974). Average movement along the edge of a stream pond in Pennsylvania was 10.1 feet (3.1 m) for females and 11.2 feet (3.4 m) for males; most individuals remained within 5 feet (1.5 m) of shore (Bellis 1968). Haas (1981) reported that all movement was random for males in a Virginia pond and so considered males to be nonterritorial.

Red-spotted Newt (Continued)

Notophthalmus v. viridescens)

FOOD HABITS/PREFERENCES: Both larvae and adults (Hamilton 1932) are opportunistic feeders (Burton 1977). Insects and their larvae, particularly mayfly, caddisfly, stonefly and mosquito larvae (Ries and Bellis 1966), hellgrammites (MacNamara 1977); tadpoles, frog eggs, earthworms, leeches, small mollusks and crustaceans, spiders, mites, occasionally small minnows (Hamilton 1932), salamander eggs also a major food item (T. Tynan, personal communication). Also ingests molted skin. Aquatic insects are an important food source for the red eft (Burton 1976). Cannibalism on their own larvae provides an important component of the diet in July and August (Burton 1977).

COMMENTS: Mates in ponds and streams. The red eft remains on land for 2 to 7 years; most remain on land 4 to 5 years, then return to the water where they transform to aquatic adults (Healy 1974). Neotenic individuals have been found on the Coastal Plain in Massachusetts and in New York (Bishop 1941:73-75). Some individual populations omit the terrestrial eft stage. Skin secretions of red efts are highly toxic — about 10 times more toxic than those of adults (Brodie 1968).

KEY REFERENCES: Bishop 1947, Mecham 1967.

Northern Dusky Salamander

(*Desmognathus f. fuscus*)



RANGE: Southern New Brunswick and s. Quebec to se. Indiana and c. Kentucky to the Carolinas; throughout the Northeast excluding s. New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to abundant.

HABITAT: In woodlands at the margins of cool running water — favors clear rocky streams, in springy banks, seepage areas, beds of semidry brooks; under the cover of wet leaves, moss, rock piles, other debris, or in burrows in the soil. Ventures from streamside only during wet weather. Occurs from sea level to mountain elevations. Moves under logs and rocks in deeper water to hibernate in September. May remain active throughout the winter in stream bottoms or deep in unfrozen soil (Ashton and Ashton 1978). Formerly found in bluffs overlooking the Harlem River in Manhattan (Gans 1945).

SPECIAL HABITAT REQUIREMENTS: Permanent streams or seeps in woodlands.

AGE/SIZE AT SEXUAL MATURITY: Variable: about 3 years (Dunn 1926:92), most males at 3.5 years, females deposit first eggs at 5 years (Organ 1961). Some males mature at 2 years, females at 3 years (Danstedt 1975). Body size at maturity varies among populations (Tilley 1968).

BREEDING PERIOD: Breeding occurs in either late spring or fall (Bishop 1941:212-213). Possible that females

breed biennially (Organ 1961). Breeds in ponds and streams.

EGG DEPOSITION: June to September in Connecticut (Babbitt 1937). Female guards the eggs in damp hollows beneath stones, under loose bark of logs, between wet leaf litter layers and in moss close to the water's edge. Larvae move to water where development continues (Stewart, personal communication). Clutches found less than 50 cm from the edge of streams and springs or seepage areas (Krysik 1980).

NO. EGGS/MASS: 8 to 28 stalked eggs in compact clusters, average 17 (Bishop 1941:314).

TIME TO HATCHING: 7 to 8 weeks in Massachusetts (Wilder 1917), 5 to 8 weeks, New York (Bishop 1941:318), about 10 weeks, Connecticut (Babbitt 1937:16).

LARVAL PERIOD: 7 to 10 months, usually transform in July (Wilder 1913:295). From 9 to 12 months in Maryland (Danstedt 1975).

HOME RANGE/MOVEMENT: Less than 10 feet (3 m) along stream in a wooded ravine in Pennsylvania (Bartholomew and Bellis 1969). Average range of 1.4 m² in a grassy bottom stream in Ohio (Ashton and Ashton 1978). Average

Northern Dusky Salamander (Continued)

Desmognathus f. fuscus)

ge about 150 square feet (14 m^2) along a stream in Kentucky, maximum movement of 100 feet (30.5 m) as open water dried up (Barbour 1971:57). Average weekly movement less than 0.5 m (Ashton 1975). In an intermittent mountain stream, average for 5 individuals was 48 m^2 daily movements less than 2 m (Barbour et al. 1969b).

FOOD HABITS/PREFERENCES: Small aquatic and terrestrial vertebrates, insects — 96 percent of prey by weight (Burton 1976), grubs, worms, crustaceans, spiders, and

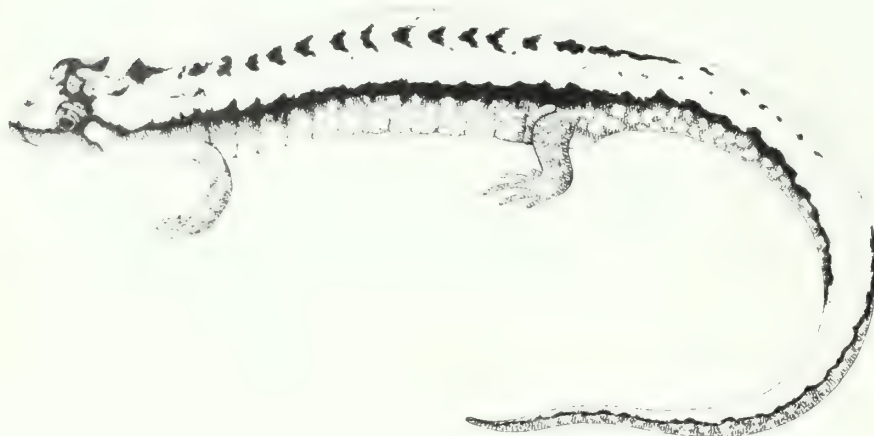
occasionally mollusks; sometimes larvae of own species. Nocturnal feeder, also active on cloudy or rainy days.

COMMENTS: Larval stage is aquatic; adults are riparian. Healy (1974) found efts most active on the forest floor when temperatures were above 13°C (55°F) and substrate was moist.

KEY REFERENCES: Ashton 1975, Bishop 1947, Organ 1961.

Mountain Dusky Salamander

(*Desmognathus ochrophaeus*)



RANGE: Appalachian mountains and uplands from New York to n. Georgia at altitudes ranging from a few hundred feet (approximately 60 m) above sea level to timberline in the s. Appalachians. One juvenile specimen from central Vermont, identification debated (Lazell 1976).

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: Semiterrestrial, found along stream edges and on the forest floor. In wet woods under forest debris, logs, stones, sometimes beneath the bark of dead trees. Near water — small streams, springs, or seeps. Seeps and springs used for late autumn and winter hibernation. Individuals inhabiting seepage banks are active earlier in spring and later in the fall than streamside individuals (Keen 1979).

SPECIAL HABITAT REQUIREMENTS: Seeps, springs, or streams in woodland areas.

AGE/SIZE AT SEXUAL MATURITY: About 3 years: females at 36 months deposit clutch; snout to vent length is 30 to 34 mm (Keen and Orr 1980).

BREEDING PERIOD: Spring, autumn, or winter (Fitzpatrick 1973).

EGG DEPOSITION: Annual cycle occurring in late winter/spring or autumn, female guards eggs.

NO. EGGS/MASS: 11 to 14 eggs (Bishop 1941:335). Stalked eggs deposited in clusters underneath stones or

logs in small cavities. Fecundity in *Desmognathus* depends on size (Tilley 1968).

TIME TO HATCHING: 50 to 70 days (Tilley 1972), hatching in fall and early spring.

LARVAL PERIOD: 2 to 8 months (Tilley 1970); in the southern Appalachians, larvae occasionally overwinter (Tilley 1973:129.1).

HOME RANGE/MOVEMENT: Average movement of 40 to 45 cm between captures of displaced and nondisplaced individuals in a rock-face habitat in North Carolina (Huheey and Brandon 1973). Homing to the nest shown by breeding females (Forester 1979). Females are philopatric, ovipositing in the same section of a stream in successive years (Forester 1977).

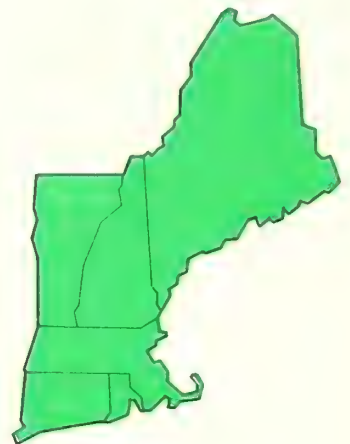
FOOD HABITS/PREFERENCES: Insects, including adult and larval forms of flies, beetles, wasps, and ants. Oligochaetes (Keen 1979), also takes other small arthropods (Huheey and Brandon 1973). Eats shed skin (Bishop 1941:341).

COMMENTS: Basically nocturnal but also active on dark humid days. Will climb trees and shrubs to feed.

KEY REFERENCES: Bishop 1947, Hairston 1949, Huheey and Brandon 1973, Tilley 1973.

Redback Salamander

(*Plethodon cinereus*)



RANGE: Nova Scotia w. to s. Ontario and e. Minnesota, s. scattered colonies to Missouri, in the Smoky Mountains, in s. Tennessee and e. to Cape Hatteras.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Entirely terrestrial. Mixed deciduous or coniferous woods, inhabiting interiors of decaying logs and stumps, also found underneath stones, moist leaf litter, tree bark. Wet areas and extremely moist bottomland habitats. Enters xeric, sandy habitats where moist microhabitats exist (M. Klemens, personal communication).

HIBERNATION: Hibernates down to 15 inch (38 cm) soil depth (Oliver 1955:121) or in rock crevices. May be active during mild weather (Minton 1972:67). In Indiana, individuals were found active in an ant mound throughout the winter (Coldwell 1975). Found hibernating a 30 to 36 inch (76.2 to 91.4 cm) depth in decaying root systems of dead white oaks in se. Massachusetts (Hoff 1977). Has been found hibernating in aquatic situations in Maryland (Cooper 1976).

SPECIAL HABITAT REQUIREMENTS: Logs, stumps, rocks, and so on.

SIZE AT SEXUAL MATURITY: Generally during second year (Oliver 1955:277), but female usually reproduces in third year (Burger 1935). Males at 42.0 mm snout to vent length, females 44.8 mm snout to vent length in Michigan (Werner 1971).

BREEDING PERIOD: Biannual cycle, spring and late fall (October through December) in Maryland (Sayler 1966).

EGG DEPOSITION: June to July of next year.

NO. EGGS/MASS: 3 to 14 eggs, average 7 to 10, in small clusters attached to roof of small chamber, laid in and under rotted logs and stumps. Reproduce annually in Connecticut (Lotter 1978).

TIME TO HATCHING: 30 to 60 days (Oliver 1955:234), extending to 84 days in Maine (Banasiak 1974). Hatch in August to September. Larval stage is completed within egg.

HOME RANGE/MOVEMENT: Home range is small due to restricted horizontal movement (Taub 1961). Movement of less than 1 foot (30.5 cm) for 14 individuals in hardwood forest habitat in New Jersey; individuals usually found under the same object where initially captured (Taub 1961). Home ranges of 13 m² for females, about 24 m² for males were determined in a northern hardwood forest in Michigan (Kleeberger and Werner 1982).

FOOD HABITS/PREFERENCES: Small insects and their larvae, earthworms, snails, slugs, spiders, sowbugs, millipedes, mites (Surface 1913:95). Occasionally cannibalistic. Mites were the most important food, accounting for

Redback Salamander (Continued)

(*Plethodon cinereus*)

65 percent of the prey items in a New Hampshire study (Burton 1976), insects 73 percent by weight in a New York study (Jameson 1944). During rainy summer nights, found on leaf litter presumably foraging for food (Burton and Likens 1975). Often climbs tree trunks and shrubs in search of food, particularly during wet nights.

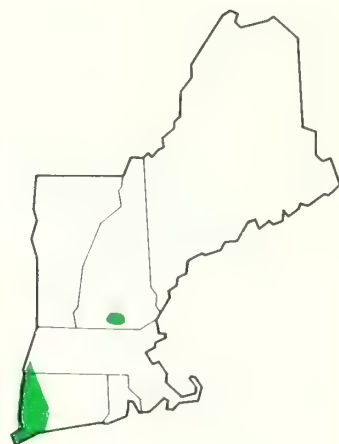
COMMENTS: Three distinct color phases occur: redback, leadback, and erythrystic. In Connecticut, the redback morph occurs almost exclusively in cold upland areas;

in areas of more moderate climate and elevation, both redback and leadback morphs occur (M. Klemens, personal communication). All records of erythrystic individuals occur north of 41° and south of 47° latitude (Talley et al. 1982). The redback salamander is the most abundant terrestrial vertebrate in New England and accounts for the greatest amount of vertebrate biomass in the Hubbard Brook Experimental Forest in New Hampshire (Burton and Likens 1975).

KEY REFERENCES: Heatwole 1962, Smith 1963.

Limy Salamander

(*Ambystoma g. glutinosus*)



RANGE: Extreme w. Connecticut through c. New York to Oklahoma, Arkansas, s. in Louisiana to c. Florida. Scattered colonies in s. New Hampshire and Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Moist wooded hillside and ravines. Terrestrial, found underneath moist humus, manure piles, in crevices in rock, shale banks, and under logs in woodland areas. Bishop (1941:718) found the species most abundant in banks along highways and woodland openings. It has been found in second-growth oak-hickory forests on steep hemlock slopes of ravines in the Helderberg Mountains, New York (M. Stewart, personal communication), to an elevation of 1,768 m in Great Smoky Mountains National Park (Powders and Tietjen 1974). Also in mature mixed deciduous forests (Semlitsch 1980a). Hibernates underground from November to March or April.

SPECIAL HABITAT REQUIREMENTS: Rock outcroppings, found within wooded areas.

AGE/SIZE AT SEXUAL MATURITY: Females mature at about 3 years and lay eggs in the fifth year, males at 4 years (Highton 1962). Snout to vent length is 59 to 74 mm in females, 53 to 70 mm in males (Highton 1962).

FEEDING PERIOD: Autumn and spring (Highton 1956).

EGG DEPOSITION: Probable biennial oviposition occurs in late spring or early summer in northern populations (Highton 1962). Eggs laid within rock crevices or

rotted logs (Smith 1961:58), also found in caves (Bishop 1941:224).

NO. EGGS/MASS: 13 to 34 eggs, average 16 to 17 (Highton 1962). Eggs aggregated in a thin envelopment. Fecundity increases with body size. (Semlitsch 1980a).

TIME TO HATCHING: Probably in late summer; entire larval period spent within egg.

HOME RANGE/MOVEMENT: Twenty-two individuals in n. Florida were recaptured at or within 4 feet (1.2 m) of the original capture point (Highton 1956). Adult home ranges are less than 9 m diameter; immatures range is less than 6 m diameter, in oak-hickory forest with thick leaf litter in North Carolina. Mean movement distances were 17.5 m for males, 14.3 m females, and 4.2 m juveniles. Probably capable of movements more than 90 m beyond home-range area (Wells and Wells 1976).

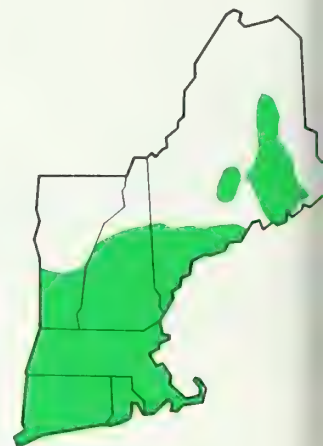
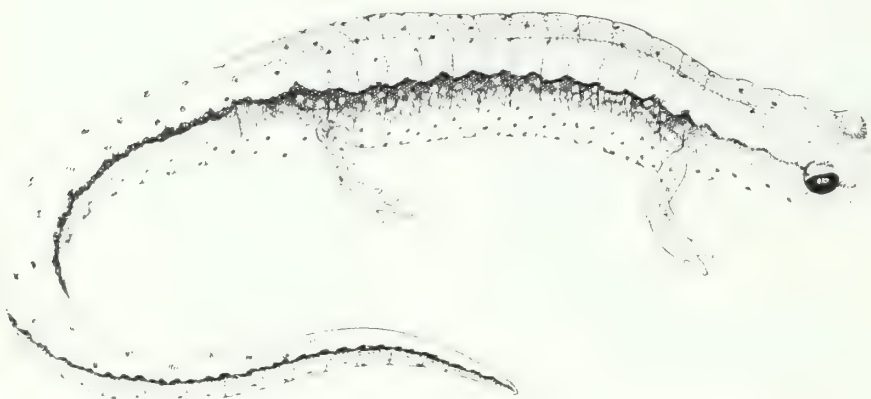
FOOD HABITS/PREFERENCES: Euryphagic (Powders and Tietjen 1974). Mostly insects, also sowbugs, worms, centipedes, spiders, slugs, and snails (Hamilton 1932). Availability probably governs feeding habits. Ants and beetles were the most abundant food items in a Virginia study, accounting for 58 percent of the total weight of food (Davidson 1956).

COMMENTS: Nocturnal, may be active during some rainy days. During hot, dry spells found deep underground or under logs in dense aggregations (Wells and Wells 1976).

KEY REFERENCES: Bishop 1941; Highton 1956, 1962.

Four-toed Salamander

(*Hemidactylium scutatum*)



RANGE: Nova Scotia w. to s. Ontario and Wisconsin, s. to Alabama and Georgia. Absent from most of n. New England. Scattered disjunct populations occur in the Eastern United States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Wet woodlands, preferably with sphagnum moss; shaded, shallow woodland pools; tamarack bogs. Hides in moss, in moist decaying wood, under stones or wet leaves. Prefers an acidic environment. Found in beech/maple, yellow birch/maple and other hardwood forests, found less often in coniferous woods (Neill 1963:2.1). In mixed forests in New York (Bishop 1941:190). Larval stage is aquatic, found in pools and quiet streams with an abundance of moss. Typically hibernates in decaying root systems of trees. Aggregations may appear during hibernation with rotted wood or leaf litter (Blanchard 1933b). Maple, alder sapling swamp in Connecticut (C. Raithel, personal communication).

SPECIAL HABITAT REQUIREMENTS: Acidic wet woodlands.

AGE/SIZE AT SEXUAL MATURITY: About 2-1/2 years (Barbour 1971:74).

BREEDING PERIOD: Late summer and autumn, peak in fall. Breeding area adjacent to mixed hardwood or northern conifer woods in West Virginia (N. Green, personal observation) and Albany County, New York (M. Stewart, personal communication), and Michigan (Blanchard 1923).

EGG DEPOSITION: March to April or May (Blanchard 1934, Barbour 1971:73). Nests located next to and just above water.

NO. EGGS/MASS: 19 to 50 eggs (Dunn 1926:200, 202); average 50 in New York (Bishop 1941:183). Communal nesting may occur with up to 800 eggs laid per nest. One to four females will remain with eggs (Wood 1953). Eggs laid singly; adhered to moss, in natural cavities or in depressions formed by the female, also among roots, decaying leaves.

TIME TO HATCHING: 38 to 60 days (Blanchard 1934).

LARVAL PERIOD: 6 weeks (Blanchard 1923); as long as 10 weeks; variation in larval development depends upon pond conditions (Bishop 1941:186).

HOME RANGE/MOVEMENT: Unreported.

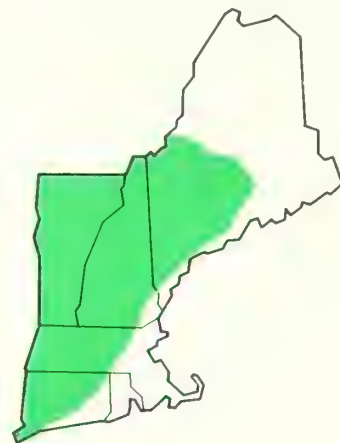
FOOD HABITS/PREFERENCES: Small invertebrates, including insects, spiders, and earthworms.

COMMENTS: A nocturnal and secretive species, therefore difficult to locate.

KEY REFERENCES: Bishop 1947, Neill 1963.

Northern Spring Salamander

Gyrinophilus p. porphyriticus)



RANGE: Through the Appalachian range from wc. Maine to extreme se. Quebec s. to e. Ohio and c. Alabama, Pennsylvania and n. New Jersey. Absent from the Coastal Plain. Recently reported from Rhode Island (C. Thel, personal communication).

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare, except in Vermont and nw. Berkshire County, Massachusetts, where common (T. Tyning, personal communication).

HABITAT: Found in but not restricted to forested areas with clear, cold water, springs, mountain streams, creeks, boggy areas. Also in depressions under stones or other cover adjacent to water. Usually occurs at higher elevations in spruce/fir forests, typically in moist situations, in underground water courses and limestone caves (N. Green, personal observation), beech/maple/hemlock forests, in shale ravine streams in Tompkins and Albany Counties, New York (M. Stewart, personal communication). Have been found in hillside meadow streams, swamps, and lake margins.

SPECIAL HABITAT REQUIREMENTS: Streams, seeps, or springs. In winter, wet soil near water where remains somewhat active in burrows.

AGE/SIZE AT SEXUAL MATURITY: 4 to 5 years, at total length of about 5-1/2 inches (14 cm) in New York (Bishop 1941:370).

BREEDING PERIOD: Mid-October to winter months (Bruce 1972). Annual reproduction cycle (Bruce 1969).

EGG DEPOSITION: April to summer and into the fall (Bruce 1972), female guard eggs (Organ 1961).

NO. EGGS/MASS: 9 to 63 (Bruce 1972), 44 to 132 eggs, New York (Bishop 1941:247), 44 to 66, Virginia (Organ 1961). Eggs laid in running water under logs and stones, usually in groups, sometimes attached singly.

TIME TO HATCHING: Fall (Organ 1961). Hatch late summer, early fall. The young from one clutch may remain near the nest site for several months after hatching (Bruce 1980).

LARVAL PERIOD: Variable larval period, average of about 4 years. Metamorphosis occurs in late spring summer (Bruce 1980). Larvae are aquatic.

HOMERANGE/MOVEMENT: Unreported.

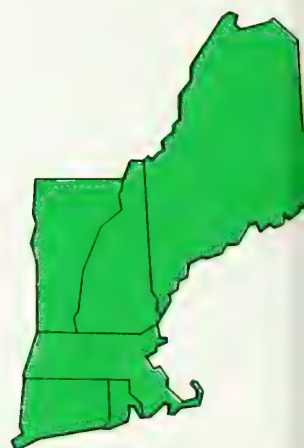
FOOD HABITS/PREFERENCES: Euryphagic predator — consumes aquatic insects and their nymph and larval forms, crustaceans, centipedes, earthworms, snails, spiders, millipedes, small frogs, and salamanders. Terrestrial insects were 79 percent of total prey items in New Hampshire (Burton 1976). Has been found to eat its own larvae (Logier 1952:76). Salamanders account for 50 percent of the diet in the Appalachians (Bruce 1972); salamanders a minor part of diet in New York (Bishop 1941:253). Nocturnal, forages for food among rocks and vegetation in or along stream beds on rainy summer nights. Larvae are generalist feeders until metamorphosis when they take larger food items (Bruce 1980).

COMMENTS: Formerly named the purple salamander.

KEY REFERENCES: Bishop 1941; Brandon 1967; Bruce 1972, 1980.

Northern Two-lined Salamander

(*Eurycea b. bislineata*)



RANGE: Gaspé Peninsula, Quebec and e. Ontario sw. through Ohio to e. Illinois, s. to extreme ne. Mississippi to Virginia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to abundant.

HABITAT: Floodplain bottoms to moist forest floors at high elevations to 1,829 m (6,000 feet) (Behler and King 1979:321). Along brooks and streams, boggy areas near springs or seeps. Found under objects at water's edge in moist soil or in coarse sand and gravel at stream bottoms or edges, leaf litter and crayfish burrows (Ashton and Ashton 1978). In wet woodlands or pastures. During wet or humid weather will wander into moist woods more than 100 m from water courses (D. Rudis, personal observation).

Hibernates under water, or remains active in feeding aggregations in springs and cold-flowing streams in New York (Stewart 1956a) and adjacent unfrozen soil (Ashton and Ashton 1978).

SPECIAL HABITAT REQUIREMENTS: Alkaline streams for breeding.

AGE/SIZE AT SEXUAL MATURITY: The majority mature during the second fall after metamorphosis (Stewart 1956a).

BREEDING PERIOD: Autumn and early spring. Breeds in streams.

EGG DEPOSITION: May to early June in Massachusetts (Johnson and Goldberg 1975).

NO. EGGS/MASS: 12 to 36 eggs, average of 18 eggs Massachusetts (Wilder 1924). Eggs deposited in clusters attached to bottoms of stones or logs in running water. Several females may use the same stone as a nest site, or female remains with eggs until hatching.

TIME TO HATCHING: 1 to 2 months after eggs laid.

LARVAL PERIOD: 2 or 3 years, aquatic (Wilder 1924).

HOME RANGE/MOVEMENT. Average area less than 14 for 20 monitored individuals along a stream in Ohio (Ashton and Ashton 1978). Territories were aggressively defended in an artificial environment (Grant 1955).

FOOD HABITS/PREFERENCES: Insects, particularly beetles, beetle larvae, mayflies, stonefly nymphs, and dipterans; also spiders, mites, millipedes, sowbugs, and earthworms (Hamilton 1932). Most prey are of terrestrial origin (Burton 1976).

COMMENTS: Will travel in the open during wet or rainy nights, rarely during wet days. Adults are extremely agile and when disturbed often escape through a series of rapid jumps.

KEY REFERENCES: Bishop 1941, Bleakney 1958, Mittleman 1966.

Eastern Spadefoot

Scaphiopus h. holbrookii



RANGE: Southeastern Massachusetts extending to New York and se. Missouri, s. to e. Louisiana and Florida. Not found in the higher elevations of the Appalachians or the Everglades of Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: In dry sandy or loose soils in sparse shrub growth or open forest areas. Terrestrial and subterranean, only enters water to breed, usually in temporary rain pools. Prefers forest areas with leaf litter (Pearson 1955). In farmland areas in Connecticut River Valley, Massachusetts, and pitch pine — scrub oak dunes in New York (Stewart and Rossi 1981). Colonies occur along floodplains of major rivers. Emerge in spring from hibernation when soil moisture is sufficient.

SPECIAL HABITAT REQUIREMENTS: Sandy soils, temporary pools for breeding.

AGE/SIZE AT SEXUAL MATURITY: During second year after metamorphosis, males at 15 months, females at 19 months (Pearson 1955).

FEEDING PERIOD AND EGG DEPOSITION: Usually April or May, extending into August; breeding is initiated by a heavy rainfall (Gosner and Black 1955). Breeds in congregations of many individuals if population is high. Usually a one-night phenomenon.

NO. EGGS/MASS: 1,000 to 2,500 eggs in masses of 6 to 110 in irregular bands in or around plants of temporary water. Eggs are very adhesive.

TIME TO HATCHING: 5 to 15 days (Oliver 1955:236).

TADPOLES: Late broods transform in 16 to 20 days (Gosner and Black 1955), 48 to 63 days for early broods (Driver 1936).

HOME RANGE/MOVEMENT: Mean home range about 10 m² 108 square feet in n. Florida, for 90 percent of captures average home range was about 6.2 m² (67 square feet); occupy one or several underground burrows within home range (Pearson 1955). Maximum dispersal distances of 9.8 m 32 feet; individuals were recaptured in the same home ranges after 5 years (Pearson 1957).

FOOD HABITS/PREFERENCES: Flies, spiders, crickets, caterpillars, true bugs, other ground-dwelling arthropods, earthworms, and snails. Moths are eaten when they can be caught (Bragg 1965:36). Tadpoles are planktonic feeders for the first few days (Richmond 1947), later becoming carnivorous and sometimes even cannibalistic.

COMMENTS: Nocturnal, peaks of activity occur just after sundown and before sunrise. Fossorial; individuals have remained in burrows an average of 9.5 days at a time, emerging to feed (Pearson 1955). Can remain underground for weeks or months during dry periods, to depths of 3 to 7 feet (1 to 2 m) (Ball 1933, cited in Babbitt 1937:20). As evidence of the spadefoot's secretive and nocturnal habits, there was a total of 16 reported sightings from 1811 to 1936 in the ne. part of its range (Ball 1936, cited in Bragg 1956).

KEY REFERENCES: Ball 1936, Bragg 1956, Pearson 1955, Wasserman 1968.

Eastern American Toad

(*Bufo a. americanus*)



RANGE: Nova Scotia and the Gaspé Peninsula w. through c. Ontario to Lake Winnipeg, s. to e. Kansas, c. Indiana, c. Alabama and c. North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Found in almost any habitat: gardens, woods, yards with cover, damp soil and a food supply. Sea level to mountain elevations. Usually in moist upland woods.

SPECIAL HABITAT REQUIREMENTS: Needs shallow water for breeding. Hibernates in burrows underground to 12 inches (30.5 cm) deep (Oliver 1955:122) from October to late March or April.

AGE/SIZE AT SEXUAL MATURITY: 3 to 4 years (Dickerson 1969:72), 2 to 3 years (Hamilton 1934).

BREEDING PERIOD AND EGG DEPOSITION: Early April to July, peak in late April in the Northeast. Travels to breeding ponds at night in large numbers (Maynard 1934).

NO. EGGS/MASS: 4,000 to 12,000 eggs (Dickerson 1969:67). Laid in long curling strings amidst aquatic vegetation.

TIME TO HATCHING: About 3 to 12 (average 4) days.

TADPOLES: 5 to 10 weeks.

HOME RANGE/MOVEMENT: Exhibits homing behavior by returning to breeding sites; 264 individuals used the same site annually in Ontario (Oldham 1966). Newly me-

tamorphosed toads showed celestial orientation when leaving ponds; as most movement is nocturnal, court determination is probably during daylight hours (D. Tyng, 1973).

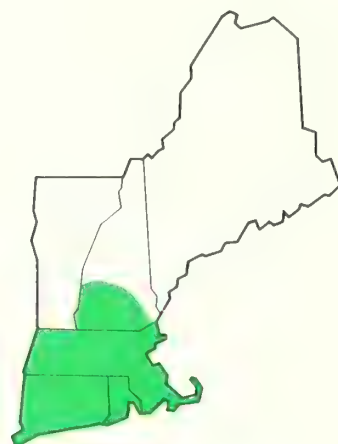
FOOD HABITS/PREFERENCES: Terrestrial arthropods, including insects, sowbugs, spiders, centipedes, and millipedes. Slugs and earthworms are other invertebrate foods. Some vegetable matter is taken accidentally. Food species determined by availability (Hamilton 1954). Feeds from twilight through the evening hours.

COMMENTS: Most active during evening hours. May be active during the day (M. Stewart, L. White, personal observation) but will seek cover during the heat of the day. Calls and breeds during the day at the peak of breeding season (T. Tyng, personal communication).

KEY REFERENCES: Hamilton 1954, Wright and Wright 1949.

Fowler's Toad

(*Bufa woodhousii fowleri*)



RANGE: Southern New England w. to c. Pennsylvania, n. shore of Lake Erie and e. shore of Lake Michigan s. Missouri, e. Oklahoma, Texas, c. Georgia and South Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon but locally abundant.

HABITAT: Prefers areas with sandy soil—shorelines, river banks, beaches, and roadside areas. Usually found in upland areas, but frequently in pine and oak forests, meadows, lawns and fields, also found in small marshy woods. Hibernates in burrows in well-drained sandy soils up to 1 foot (0.9 m) deep from early fall to late spring (May in Connecticut).

SPECIAL HABITAT REQUIREMENTS: Sandy soils, shallow water for breeding.

AGE/SIZE AT SEXUAL MATURITY: Probably breeds during 1st year (Stille 1952).

BREEDING PERIOD AND EGG DEPOSITION: Late April to mid-August (2 to 4 weeks later than *B. a. americanus*). Shallow water of pools, lake margins, ditches, and so on, necessary for breeding.

NO. EGGS/MASS: Up to 8,000 eggs laid in long strings in aquatic vegetation (Wright and Wright 1949:212).

TIME TO HATCHING: About 1 week.

TIME TO POLES: 40 to 60 days, usually transform midsummer.

HOME RANGE/MOVEMENT: Average distances between captures ranged from 22 to 32 m during a 3-year period on a golf course in Connecticut (Clarke 1974). Night movements of 200 to 700 feet (61 to 213 m) or more to reach waters' edge (Lake Michigan). Toads usually found within 100 feet (30.5 m) of previous capture point (Stille 1952).

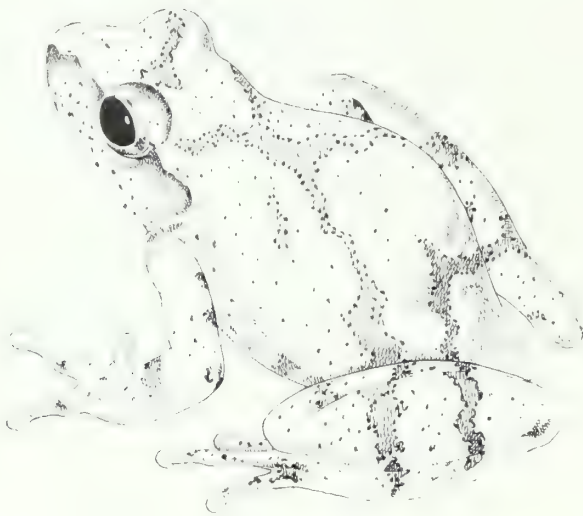
FOOD HABITS/PREFERENCES: Chiefly ground-dwelling insects, particularly ants and beetles; also consumes earthworms, spiders, snails, and slugs.

COMMENTS: During evening hours may move to edge of water to replenish body moisture (Stille 1952). May be active during the day, but typically crepuscular (Minton 1972:95). Activity periods vary with populations, mostly nocturnal in Connecticut (Clarke 1974).

KEY REFERENCES: Clarke 1974, Logier 1952, Wright and Wright 1949.

Northern Spring Peeper

(*Hyla c. crucifer*)



RANGE: Nova Scotia, the Gaspé Peninsula and Quebec to the s. tip of Hudson Bay through Ontario to Lake Winnipeg, s. to e. Texas and throughout the Eastern United States, except Florida and s. Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to abundant.

HABITAT: Marshy or wet woods, second growth woodlots, sphagnum bogs, nonwooded lowlands, near ponds and swamps. Found on the ground or burrowed into the soil. Breeds in permanent or temporary water, usually woodland ponds with aquatic debris. Found in cool moist woods after breeding (M. Stewart, personal observation). Hibernates on land during late November to January or early spring, under moss and leaves.

SPECIAL HABITAT REQUIREMENTS: Pools for breeding.

AGE/SIZE AT SEXUAL MATURITY: Early in second year at about 20 mm snout to vent length (Delzell 1958).

BREEDING PERIOD AND EGG DEPOSITION: Early March to June (in the North).

NO. EGGS/MASS: 800 to 1,000 eggs (Wright 1914:16). Laid singly near the bottom of shallow weedy ponds, attached to submerged plants (Oliver 1955:236).

TIME TO HATCHING: 6 to 12 days.

TADPOLES: 90 to 100 days (Wright 1914:42). Usually transform during July (Wright and Wright 1949:314).

HOME RANGE/MOVEMENT: In s.e. Michigan, home-range diameters ranged from 4 to 18 feet (1.2 to 5.5 m), established around forest debris and vegetation; average daily travel was 20 to 130 feet (6.1 to 39.6 m) reported Delzell (1958).

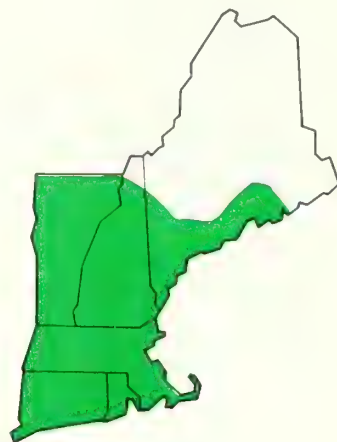
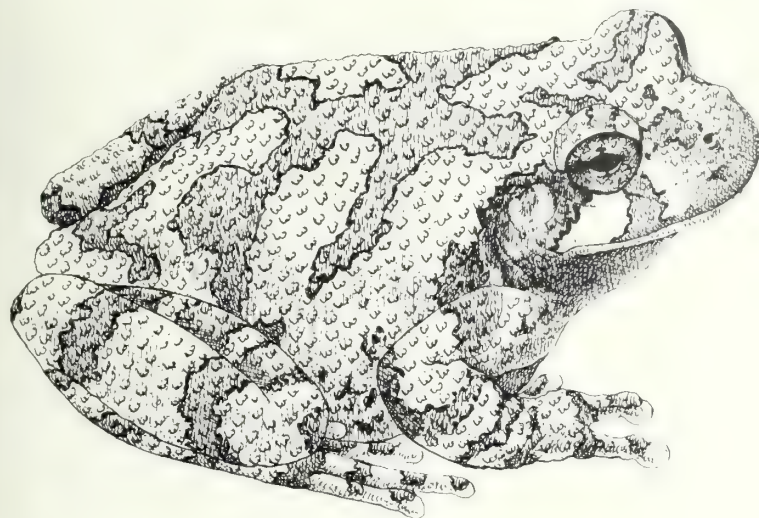
FOOD HABITS/PREFERENCES: Small nonaquatic insects, preferably ants, flying bugs, beetles, flies, springtails, and spiders; also mites, ticks, and small snails. Feeding taken probably reflect availability, catchability, and rather than preference (Oplinger 1967).

COMMENTS: Young frogs terrestrial in first year (Delzell 1958). May move long distances from breeding area in summer and fall, single calls heard from woods, shrub openings, far from water (M. Stewart, personal observation).

KEY REFERENCES: Delzell 1958, Logier 1952, Wright and Wright 1949.

Gray Treefrog

Hyla versicolor



RANGE: Eastern United States and s.e. Canada from s. Maine to Manitoba and s. through c. Texas and the Gulf states to c. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Forested regions with small trees, shrubs and bushes near or in shallow water. Often found on moss or lichen on bark of old trees. Will breed in temporary pools or permanent water, swamps, bogs, ponds, weedy lakes, and roadside ditches; breeding sites are extremely variable. Commonly inhabit moist areas in hollow trees, under loose bark, or in rotted logs during summer months, (Smith 1961:93). Hibernates under tree roots, under leaves (Babbitt 1937).

SPECIAL HABITAT REQUIREMENTS: Aquatic sites for breeding.

AGE/SIZE AT SEXUAL MATURITY: Breeds at 3 years (Palmer 1949:455).

BREEDING PERIOD: Early May to July, Connecticut (Babbitt 1937). May to August in the Southeast (Martof et al. 1980:116). Season varies with latitude (Smith 1961:93). Peak in early May, Ithaca, New York (Wright 1914:44).

EGG DEPOSITION: Generally 20 to 35 days between first appearance and first eggs (Wright 1914:47). Loosely attached to vegetation on the surface of shallow water (Martof et al. 1980:116).

NO. EGGS/MASS: Total of 1,800 to 2,000 eggs (Wright

1914:49). Packets of 10 to 40 eggs (Martof et al. 1980:116), or 4 to 25 eggs (Smith 1961:93).

TIME TO HATCHING: 4 to 5 days (Babbitt 1937).

TADPOLES: 50 to 60 days, shorter period in warmer areas. Transform late in June to September.

HOME RANGE/MOVEMENT: Unreported.

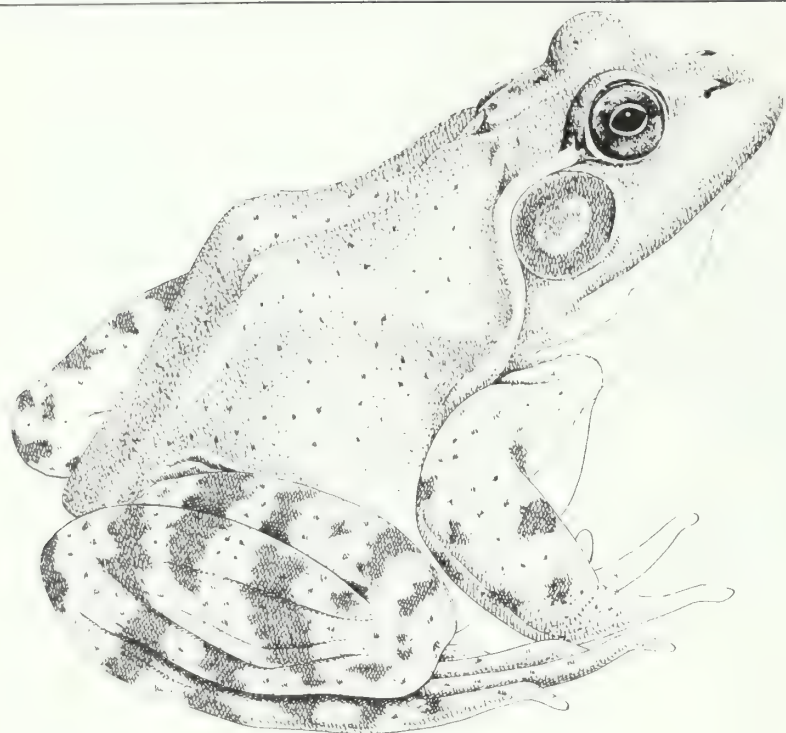
FOOD HABITS/PREFERENCES: Small insects, spiders, plant lice, mites, and snails. Forages in vegetation and on the ground (Martof et al. 1980:116).

COMMENTS: Most active during evening hours when vocal both during and out of breeding season. Rarely found outside of breeding period. Able to change color from gray to green. Young are emerald green. Single calls heard occasionally in summer during humid days, often before a storm. *H. versicolor* is a tetraploid species with 48 chromosomes (Martof et al. 1980:115). Noxious skin secretions by *H. versicolor* may repel predators (Brodie and Formanowicz 1981).

KEY REFERENCES: Logier 1952, Martof et al. 1980, Wright and Wright 1949.

Bullfrog

(*Rana catesbeiana*)



RANGE: Nova Scotia w. to Wisconsin, s. through the Great Plains to e. Colorado, Texas and ne. Mexico; throughout the Eastern United States, except s. Florida and parts of n. Maine. Introduced in California and British Columbia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common, but formerly more abundant.

HABITAT: Near shorelines of large bodies of water with emergent vegetation, lakes, river oxbows. Highly aquatic. Tend to remain in same pools for the summer months if water level is stable (Raney 1940). Will occupy floating logs far from shore. Breed close to shore lines in areas sheltered by shrubs (Raney 1940). Hibernates under water in mud and leaves about mid-October, emerges late February to March, May in New York (Wright 1914:78).

SPECIAL HABITAT REQUIREMENTS: Deep permanent water and emergent vegetation.

AGE/SIZE AT SEXUAL MATURITY: In fourth or fifth year.

BREEDING PERIOD AND EGG DEPOSITION: Late May to July (in the North), peak in July.

NO. EGGS/MASS: 12,000 to 20,000 eggs (Wright 1914:82). Eggs laid in floating films of jelly in water of lakes, quiet streams, and ponds.

TIME TO HATCHING: 5 to 20 days (Oliver 1955:237). Often 4 days or less (Wright 1914:83).

TADPOLES: For 2 to 3 winters.

HOME RANGE/MOVEMENT: Average distance traveled Summer, 200 to 300 feet (61 to 91 m) in a woodland lake and pond in New York (Raney 1940, Ingram and Raney 1943). Evening movement of 200 to 700 feet (61 to 213 m) to water in Michigan (Stille 1952). Home range of 1 bullfrogs in an Ontario pond had an average mean activity radius of 8.6 feet (2.6 m) with minimum and maximum movements of 2.0 feet (0.6 m) and 37.1 feet (11.3 m), respectively (Currie and Bellis 1969). Males defend territories during breeding season. In a Michigan study (Emlen 1968), the average distance between males within a chorus was 17.8 feet (5.4 m), implying an average minimum territorial radius of approximately 9 feet (2.7 m).

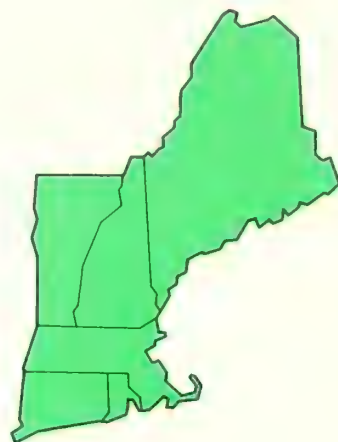
FOOD HABITS/PREFERENCES: Any available small animals; fish, other frogs, salamanders, newts, young turtles, snakes, small birds, mice, crayfish, insects, snails and spiders. Also cannibalistic. Feeds among the water weeds; an indiscriminate and aggressive predator.

COMMENTS: The bullfrog has become rare in many areas, presumably due to toxic effects of DDT and other pollutants (M. Stewart, personal communication).

KEY REFERENCES: Logier 1952, Wright and Wright 194

Green Frog

Rana clamitans melanota



RANGE: Nova Scotia through Quebec and s. Ontario to c. Minnesota, s. to e. Oklahoma and e. to n. Georgia and South Carolina. Absent from c. Illinois.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Riparian, inhabiting margins of shallow permanent or semipermanent fresh water, shores and banks of lakes and ponds, creeks, woodland streams, limestone quarry pools, springs, vernal pools, moist woodlands near water. Seldom more than a few meters from the water. Young often found in semipermanent water. Hibernates underground or underwater from October until March, usually within its home range (Martof 1953b). May be active on warm winter days.

SPECIAL HABITAT REQUIREMENT: Riparian areas.

AGE/SIZE AT SEXUAL MATURITY: Males sexually active the season following metamorphosis when 60 to 65 mm long; males mature during the second or third year when 65 to 75 mm long (Martof 1956). Some females reached maturity at 90 mm at Cranberry Lake, New York (M. Stewart, personal communication). Some may not breed until the second year after transformation (Wells 1977).

BREEDING PERIOD AND EGG DEPOSITION: April to August, peak in mid-May, varies with locality. The same female may lay two clutches (Wells 1976). Emerge from hibernation in early spring but do not breed until mid-May in Connecticut (Babbitt 1937).

NO. EGGS/MASS: 3,500 to 4,000 eggs (Wright 1914:16),

to 5,000 (Pope 1944). Eggs deposited in floating masses of jelly attached to underwater twigs and stems in permanent water.

TIME TO HATCHING: 3 to 6 days (Babbitt 1937).

TADPOLES: 1 to 2 years. Less than 1 year in southern parts of range. May transform in same season eggs are laid (Martof 1956).

HOME RANGE/MOVEMENT: Ranged from 20 m² to 200 m² with an average of 61 m² in southern Michigan near a stream and lake; daily movements were less than 10 m for 80 percent of the 824 individuals recaptured (Martof 1953b). During breeding season, males maintained a 2 to 3 m distance between each other (Martof 1953a). Territory size depends on cover density, 1 to 1.5 m between males in areas of dense cover. Territories with diameters of 4 to 6 m defended in open areas in New York (Wells 1977).

FOOD HABITS/PREFERENCES: Terrestrial feeders among shoreline vegetation. Insects and their larvae, worms, small fish, crayfish and other crustaceans, newts, spiders, small frogs, and mollusks are taken. Beetles, flies, grasshoppers, and caterpillars constituted over 60 percent of food items (Hamilton 1948). Terrestrial beetles are the most important food item (Steward and Sandison 1972). Tadpoles are herbivorous.

COMMENTS: Found in or at edge of water during daylight hours; evening hours spent along the banks feeding or in water defending territories (Wells 1977).

KEY REFERENCES: Logier 1952; Martof 1953b, 1956; Wright and Wright 1949.

Mink Frog

(*Rana septentrionalis*)



RANGE: Nova Scotia, n. New England and New York w. to n. Wisconsin and Minnesota, n. through Ontario to St. James Bay and to n. Quebec and Labrador.

RELATIVE ABUNDANCE IN NEW ENGLAND: Only in extreme northern areas, locally common to rare.

HABITAT: At the edges of northern lakes and ponds, cold springs, inlets where cold streams enter ponds and stream edges. Prefers open water with abundant lily pads. Sometimes found in northern bogs.

SPECIAL HABITAT REQUIREMENTS: Breeds and hibernates only in permanent waters. Prefers lily pads in open water for basking and foraging (M. Stewart, personal communication).

AGE/SIZE AT SEXUAL MATURITY: Males 1 year after metamorphosis, females 1 to 2 years after metamorphosis (Hedeen 1972).

BREEDING PERIOD AND EGG DEPOSITION: June to early August (Hedeen 1972), peak in July (Wright and Wright 1949:535).

NO. EGGS/MASS: One individual laid 509 eggs (Hedeen 1972). Eggs laid in globular jelly-like masses attached to aquatic vegetation such as spatterdock (*Nuphar*) then drop to bottom where they develop (M. Stewart, personal communication).

TIME TO HATCHING: Unreported.

TADPOLES: For 1 to 2 years. Transform during summer months.

HOME RANGE/MOVEMENT: Unreported.

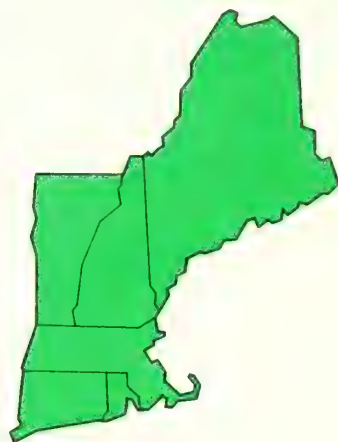
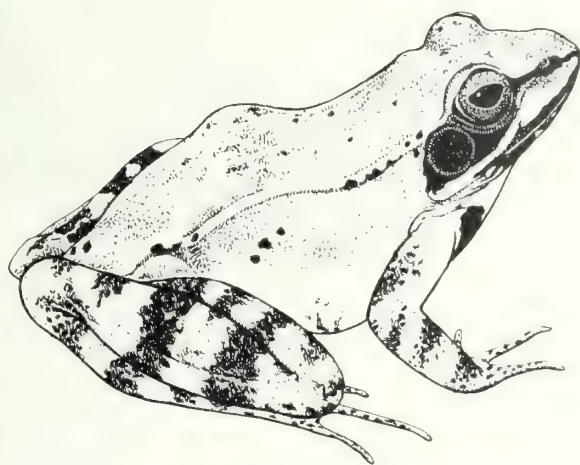
FOOD HABITS/PREFERENCES: Adults feed from lily pads or animal matter, including adult insects and larvae, particularly aphids and chrysomelids (Kramek 1972, 1976); also minnows, millipedes, leeches, snails, spiders; plant material taken inadvertently. Most prey taken from the water surface—usually opportunistic feeders, but can be selective (Kramek 1972). Diet is a reflection of prey species availability. Tadpoles feed primarily on algae (Hedeen 1970).

COMMENTS: Very similar to *R. clamitans melanota* in appearance and habits. Adults produce a musky scent, especially when handled roughly (Conant 1975:342). Competition from green frogs and bullfrogs may be an important factor in habitat selection in the Northeast (M. Stewart, personal communication). In ponds treated with rotenone in the Adirondacks, the anuran community of green, mink, and bullfrogs probably requires 10 to 15 years to recover to pretreatment levels (Stewart 1975).

KEY REFERENCES: Hedeen 1977, Logier 1952, Marshall and Buell 1955.

Wood Frog

Rana sylvatica)



RANGE: Atlantic provinces and n. Quebec to Alaska (northern limit is along treeline) s. into North Dakota, the Great Lakes States, to the Appalachians in Tennessee and extreme n. Georgia. Throughout the Northeast.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in suitable habitat.

HABITAT: Terrestrial; in mesic woods, often far from water during the summer months as woodland ponds dry up; xeric woods with moist microhabitats (M. Klemens, personal communication). Prefers wooded areas with small ponds for breeding (Heatwole 1961). Found in boreal conifer forests, swamps and upland hardwood forests to elevations of 1,158 m, (Trapido and Clausen 1938). Found in bogs and trap rock slopes in Connecticut (M. Klemens, personal communication). Hibernates under moist forest floor debris or flooded meadows (M. Klemens, personal communication) from October to late March. Embryos and larvae showed limited tolerance to winter with a high humic content in a Minnesota peat bog (Jarns 1980).

SPECIAL HABITAT REQUIREMENTS: Prefers temporary woodland pools, back waters of slow-moving streams.

AGE/SIZE AT SEXUAL MATURITY: Males at 2 years, females at 3 years (Bellis 1961).

FEEDING PERIOD AND EGG DEPOSITION: March to July at temperatures of about 10°C (50°F) (Smith 1956:113). Moore (1939) found maximum temperature tolerance of 2°C (75°F) for egg development. Often breeds before ice is off the water (Martof 1970:86.2). Egg-laying usually completed within 4 to 6 days (Herreid and Kinney 1967).

NO. EGGS/MASS: 2,000 to 3,000 eggs (Wright 1914:16), 1,019 average in Massachusetts (Possardt 1974).² Eggs attached to submerged twigs or free on the bottom in globular masses.

TIME TO HATCHING: 10 to 30 days (Oliver 1955:236), temperature dependent.

TADPOLES: 6 to 15 weeks (Minton 1972:132). May overwinter in n. Canada.

HOME RANGE/MOVEMENT: Average home-range size for 453 individuals in a Minnesota peat bog was 77.2 square yards (65.5 m²), range 3.5 to 440.5 square yards (2.9 to 368.3 m²). Distance between captures averaged 12.3 yards (11.2 m) and ranged from 0 to 78 yards (0 to 71.3 m) as reported by Bellis (1965).

FOOD HABITS/PREFERENCES: Insects; particularly beetles, flies and hymenopterans (Moore and Strickland 1955), also spiders, snails, slugs, and annelids.

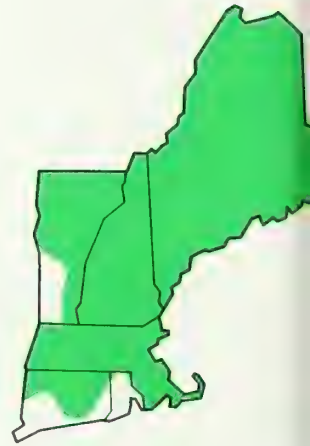
COMMENT: Breeds before all other ranids in the Northeast. Adults have been observed migrating across surface ice toward chorusing wood frogs (T. Andrews, personal observation). Brush piles, grassy hummocks, and other terrestrial objects used as cover rather than utilizing aquatic escape (Marshall and Buell 1955).

KEY REFERENCES: Heatwole 1961, Martof 1970, Wright and Wright 1949.

²Possardt, E. E. The breeding biology and larval development of the wood frog (*Rana sylvatica*). Dept. For. and Wildl. Manage., Univ. Mass., Amherst. Unpublished.

Northern Leopard Frog

(*Rana pipiens*)



RANGE: Nova Scotia, S. Labrador to se. British Columbia, to e. parts of Oregon, Washington and California, to n. Arizona and New Mexico, and to Ohio, n. New York and New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common; spotty distribution in southern part of range, very uncommon in parts of formerly occupied range.

HABITAT: Commonly found in wet open meadows and fields and wet woods during summer months. River floodplains, Connecticut (M. Klemens, personal communication). Breeds in ponds, marshes, slow shallow streams, and weedy lake shores. Usually hibernates from October or November to March, hibernates under water or in caves (Rand 1950). Sometimes emerges in early February (Smith 1956:110) and during warm days in winter (Zenisek 1964).

SPECIAL HABITAT REQUIREMENTS: Wet meadows.

AGE/SIZE AT SEXUAL MATURITY: At 3 years of age in Michigan (Force 1933).

BREEDING PERIOD AND EGG DEPOSITION: March to May, congregates to breed (Wright and Wright 1949:482).

NO. EGGS/MASS: 4,000 to 6,500 eggs laid in masses in shallow water, sometimes attached to twigs.

TIME TO HATCHING: 13 to 20 days (Wright 1914:58).

TADPOLES: 9 to 12 weeks, transform July and August. Overwinter as tadpoles in Nova Scotia (Bleakney 1952).

HOME RANGE/MOVEMENT: Daily travel within home range reported to be usually less than 5 to 10 m in wet pasture and marsh (Dole 1965). Average nightly movement during rainy periods was 36 m in Michigan (Dole 1968). Occasional long-range movement, often exceeding 100 m during rainy nights (Dole 1965).

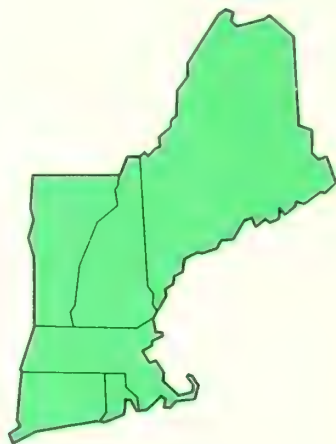
FOOD HABITS/PREFERENCES: Insects; particularly beetles, lepidopteran larvae, wasps, bugs, crickets, grasshoppers, and ants; also takes sowbugs, spiders, small crayfish, snails, and myriopods. Almost 99 percent of food items were insects and spiders (Drake 1914). Occasional records of having taken small birds and snakes. Food species taken correlates with peaks in insect productivity (Linzey 1967).

COMMENTS: During dry summer days frogs may sit in "forms," small clearings made in wet soil within the home range (Dole 1965). Most northeastern leopard frogs are probably introduced "exotics" released from laboratories and classrooms. Some believe the species is not native to New England (T. Tynning, personal communication).

KEY REFERENCES: Dole 1968, Logier 1952.

Pickerel Frog

(*Rana palustris*)



RANGE: Nova Scotia and the Gaspé Peninsula through Ontario to Wisconsin se. to e. Texas and ea. to South Carolina. Absent from C. Illinois, nw. Ohio and parts of South.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Colder waters of lakes, ponds, clear streams, springs, sphagnum bogs, limestone quarry pools. In Massachusetts, fairly ubiquitous along streams and shores of permanent ponds and lakes (T. Andrews, personal communication). In summer found in pastures, fields, or woodlands, often at a distance from water. Prefers water with thick vegetation at edges for cover. Hibernates in mud at bottom of ponds or in ravines under stones from October to March. Some individuals found hibernating in caves in Indiana (Rand 1950).

SPECIAL HABITAT REQUIREMENTS: Shallow, clear water of bogs and woodland ponds for breeding.

AGE SIZE AT SEXUAL MATURITY: Unreported.

BREEDING PERIOD AND EGG DEPOSITION: March to May.

NO. EGGS/MASS: 2,000 to 3,000 eggs (Wright 1914:67). Eggs laid in firm globular masses attached to submerged plants and branches.

TIME TO HATCHING: 11 to 21 days (Wright 1914:67).

TADPOLES: 80 to 100 days, some overwinter as tadpoles. Transform July to September.

HOME RANGE MOVEMENT: Unreported.

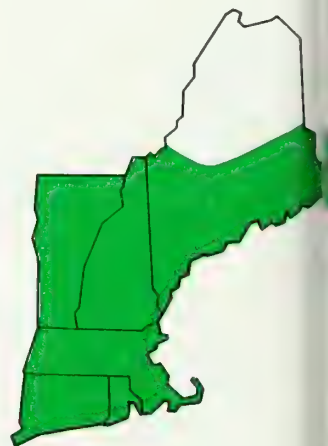
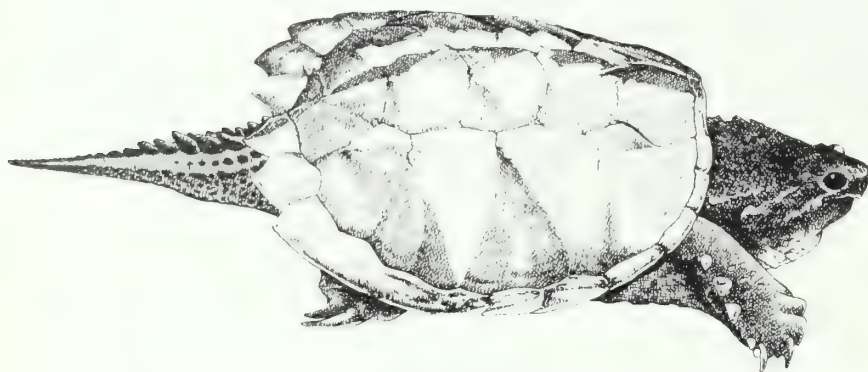
FOOD HABITS PREFERENCES: In adults, 95 percent of food items were terrestrial arthropods (Smith 1956:108). Snails, small crayfish, aquatic amphipods and isopods are also eaten.

COMMENTS: Diurnal; may be crepuscular during hot weather. Sensitive to pollution and changes in water quality. Skin secretions may be toxic to other amphibians confined with pickerel frogs.

KEY REFERENCES: Schaaf and Smith 1971, Smith 1956, Wright and Wright 1949.

Common Snapping Turtle

(*Chelydra s. serpentina*)



RANGE: Across the Eastern United States to the Rocky Mountains, s. Canada to the Gulf of Mexico and into Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Bottom dweller in any permanent and many semipermanent bodies of fresh or brackish water; occasionally in temporary water. Marshes, swamps, bogs, pools, lakes, streams, rivers, frequently in areas with soft muddy banks or bottoms. Formerly thought to prefer permanent water. Almost entirely aquatic, but will travel overland. Hibernates from October to March or April in mud or debris in lake bottoms, banks, and muskrat holes, but has been seen walking on and under the ice (Carr 1952:64). Little known about winter activity.

SPECIAL HABITAT REQUIREMENTS: Aquatic habitat.

AGE/SIZE AT SEXUAL MATURITY: Carapace length of 10 inches (25.4 cm) reported by Hammer (1969).

BREEDING PERIOD: Late April to November, sperm may remain viable in females for several years.

EGG DEPOSITION: Mid-June. Nests made in soil of banks or in muskrat houses. Also on lawns, driveways, fields, sometimes far from water.

CLUTCH SIZE: 11 to 83 eggs; females may lay two clutches per year in southern portions of range. Typically 20 to 30 eggs per clutch (Cahn 1937, cited in Conant 1938:128).

INCUBATION PERIOD: 55 to 125 days (Hammer 1969), typically 80 to 91 days, depending on environmental conditions.

EGGS HATCH: Late August to early October, may overwinter in nest until spring in northern portions of range. Nests often destroyed by mammalian predators.

HOME RANGE/MOVEMENT: Average distance traveled by 107 individuals was 0.69 mile (1.1 km), with most movement within the same marsh in South Dakota (Hammer 1969). In a New York marsh, movement of 100 m was the average for 85 individuals; home ranges from 3 to 9 ha (Kiviat 1980). Established range in Pennsylvania 4.5 acres (1.8 ha), reported by Ernst (1968b). Quite migratory. Females exhibit strong nesting site fidelity and will travel more than 0.5 km overland through forest and uneven terrain between water bodies in Ontario. Maximum round-trip distance of 16 km between home range and nesting site (Obbard and Brooks 1980).

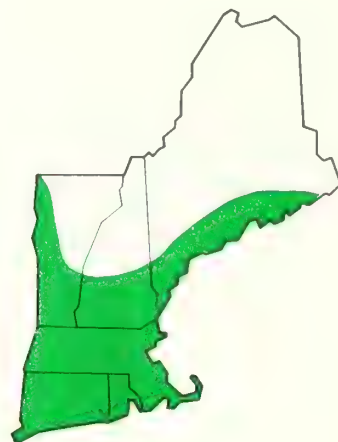
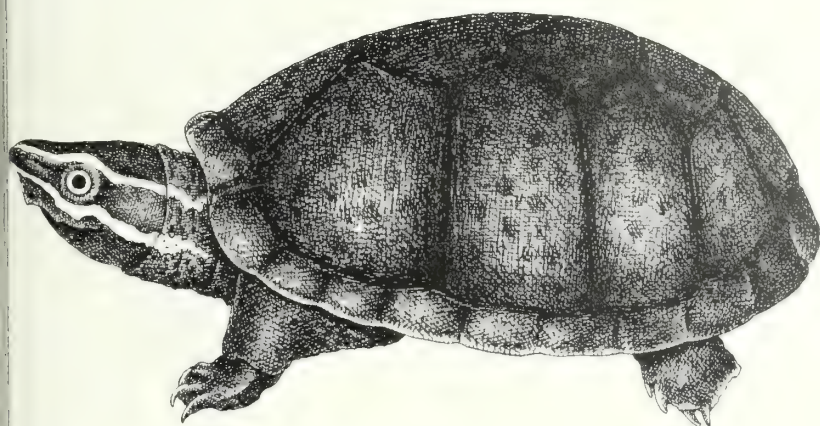
FOOD HABITS/PREFERENCES: Omnivorous feeders; animal matter accounts for 54 percent of prey items including fish (40 percent), crayfish, aquatic invertebrates, reptiles, birds, mammals; plant material 37 percent (Alexander 1943). Primary fish species in diet included suckers, bullheads, sunfish, and perch in Connecticut (Alexander 1943). May occasionally take young waterfowl; not destructive to natural population of fish or waterfowl. Scavenges for any food readily available.

COMMENTS: High levels of persistent organochlorine contaminants found in the tissues of Hudson River Specimens (Stone et al. 1980).

KEY REFERENCES: Babcock 1919, Hammer 1969, Kiviat 1980.

stinkpot

(*ternotherus odoratus*)



RANGE: Atlantic coast, s. Ontario, w. to the Mississippi River, s. to c. Texas, s. Florida. Absent from n. New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Permanent bodies of water: still, shallow, clear lakes, ponds, and rivers, muddy bottoms preferred. Frequently found in reservoirs (M. Klemens, personal communication). Refrains from using temporary water courses. Formerly thought to refrain from using water with fluctuating levels. Not in streams at higher elevations in the East. Large populations found in areas with abundant aquatic vegetation (Pope 1939:39). Scattered records for occurrence in marshes, swamps, bogs, sloughs (Pope 1939:39). Usually gregarious when hibernating in bottom mud, debris, beneath rocks in river bottoms, or in river banks when the temperature falls below 50°C (50°F) (Cagle 1942).

SPECIAL HABITAT REQUIREMENTS: Permanent water bodies. Exclusively aquatic except when laying eggs.

AGE/SIZE AT SEXUAL MATURITY: Stinkpots in the northern portions of the range mature more slowly than individuals in the southern regions. Males at 3 or 4 years, females at 2 to 7 years (Tinkle 1961), or perhaps at 9 to 11 years (Risely 1932).

SPawning PERIOD: April to October, peak in April to May, September to October.

EGG DEPOSITION: May to August, peak in June. Eggs laid on stumps, rotted logs, stumps, sandy soil, grass, or on the ground at lake margins.

CLUTCH SIZE: 1 to 9 eggs (highest numbers in North), typically 3 to 6.

INCUBATION PERIOD: 60 to 90 days (Barbour 1971:162), 35 to 40 days (Edgren 1960).

EGG HATCH: September to October (in North). Gregarious nesting habits, often malodorous.

HOME RANGE/MOVEMENT: Overland movements probably seasonal or forced (Ernst and Barbour 1972:40). Average home range is 0.06 acre (0.02 ha) for males and 0.12 acre (0.05 ha) for females in Oklahoma. Overland movements ranged from 166 to 227 feet (35.4 to 69.2 m) for males, and 113 to 146 feet (34.4 to 44.5 m) for females (Mahmoud 1969). Exhibited homing behavior in Michigan—13 out of 28 released individuals traveled up to 700 feet (213 m) to initial capture points (Williams 1952).

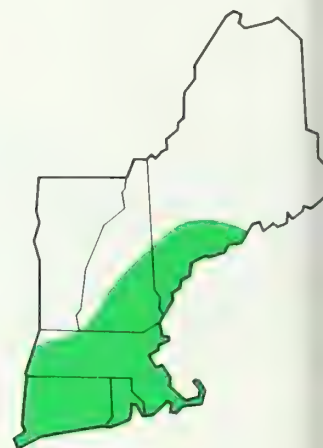
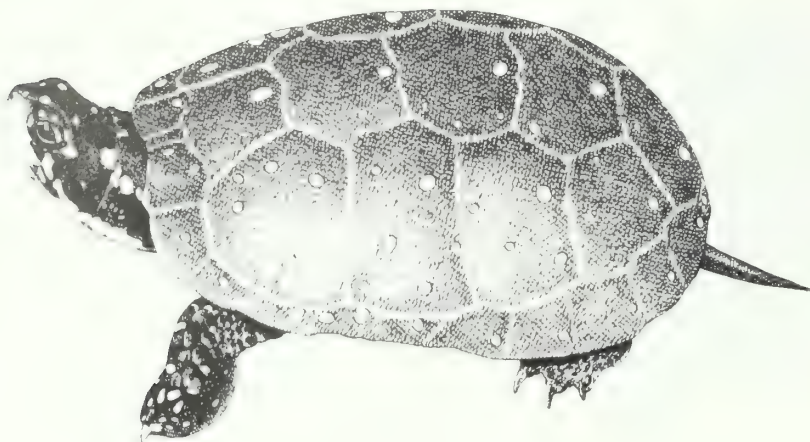
FOOD HABITS/PREFERENCES: Principally carnivorous, feeds along the bottom for snails, clams, aquatic insects and their larvae, particularly dragonfly nymphs and caddisfly larvae (Lagler 1943), minnows, worms, tadpoles, and fish eggs (Babcock 1919:36). While scavenging, plants and algae as well as carrion are eaten. Carrion accounted for 40 percent of the diet by volume for 73 individuals in Michigan (Lagler 1943).

COMMENTS: Also called the musk turtle. Often basks well out of water on horizontal limbs of slanting trees along the water's edge. Highly aquatic; activity periods in morning and evening in Oklahoma (Mahmoud 1968). Individuals frequently covered with algae growth.

KEY REFERENCES: Ernst and Barbour 1972, Mahmoud 1969.

Spotted Turtle

(*Clemmys guttata*)



RANGE: Southern Marine to s. Quebec w. to Lake Michigan, n. half of Ohio to e. portion of Virginia s. to n. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: In unpolluted, small shallow bodies of water such as woodland streams, wet meadows, bog holes, small ponds, marshes, swamps, roadside ditches, and brackish tidal creeks. In Rhode Island, found in salt marshes and small bogs or ponds with adjacent dry upland oak-pine forest (C. Raithel, personal communication). Prefers areas with aquatic vegetation. Hides in mud and detritus at bottom. Wanders over land. Basks along water's edge on brush piles in water (T. Graham, personal communication) and on logs or vegetation clumps. Often found in cranberry bogs. Hibernates in muddy bottoms during the coldest winter months. May aestivate during hottest periods of summer (T. Tynning, personal communication).

SPECIAL HABITAT REQUIREMENTS: Unpolluted shallow water.

AGE/SIZE AT SEXUAL MATURITY: Males about 83.4 mm plastron length, females about 80.8 mm plastron length in Pennsylvania (Ernst and Barbour 1972:73).

BREEDING PERIOD: March to May, peak usually June.

EGG DEPOSITION: June to July. Eggs usually laid in well-drained soil of marshy pastures, or in tussocks (M. Klemens, personal communication).

CLUTCH SIZE: 1 to 8 eggs (Adler 1961), average 3 to 5.

INCUBATION PERIOD: 70 to 83 days.

EGGS HATCH: Late August (Ernst and Barbour 1972:74 to September (Finneran 1948). Overwintering in nest may occur.

HOME RANGE/MOVEMENT: For adults in Pennsylvania marsh range averaged 1.3 acre (0.5 ha) according to Ernst (1968b); moved less than 0.5 mile (0.8 km) (Ernst 1968a). Females migrate outside of home range to nest (Ernst 1970).

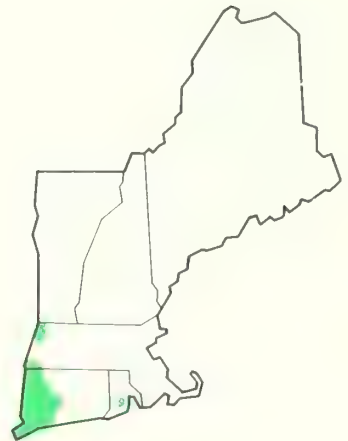
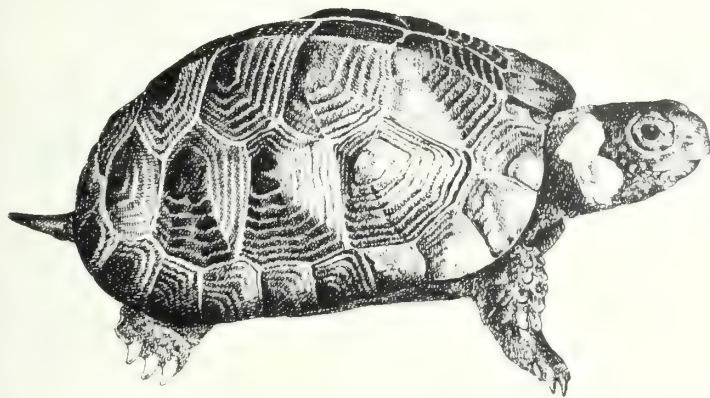
FOOD HABITS/PREFERENCES: Omnivorous. Eats crustaceans, mollusks, spiders, earthworms, aquatic insects and other invertebrates; occasionally takes frogs and tadpoles, small fish, carrion, and vegetable matter. Food taken only under water.

COMMENTS: Overcollecting, coupled with draining and filling of swamps (and possibly pollution), is depleting the population. A strongly diurnal species (Graham and Hutchinson 1979).

KEY REFERENCES: Ernst 1972a, Ernst and Barbour 1972, Stewart 1974.

Bog Turtle

(*Clemmys mühlenbergii*)



RANGE: Scattered colonies through New York, s. to ne. Maryland, s. Virginia, w. North Carolina and Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Endangered (U.S. Department of Interior 1980).

HABITAT: Unpolluted open sphagnum bogs or wet meadows; sluggish clear meadow streams with muddy or rocky bottoms (Zappalorti et al. 1979).³ Frequents shallow meandering waterways in swamps and wet meadows. In Connecticut, associated with open canopy and bare wetlands (M. Klemens, personal communication). Hibernates midautumn to late March or April. Hibernaculum is in a subterranean rivulet or seepage area with continually flowing water in New Jersey (Zappalorti and Farrell 1980).⁴ Commonly basks in spring and early summer. In New Jersey bogs, individuals found basking on sedge grass tussocks or in open shallow pools (Zappalorti et al. 1979).

SPECIAL HABITAT REQUIREMENTS: Abundance of grassy or mossy cover, high humidity, and full sunlight.

Zappalorti, R. T.; Farrell, R. F.; Zanelli, E. M. 1979. The ecology and distribution of the bog turtle, *Clemmys mühlenbergii* (Schoepff), in New Jersey, Pt. 2. Report to the New Jersey Dept. of Environ. Protection, Endangered and Nongame Spec. Proj., Federal Aid Prog. and Herpetological Associates. HA Rept. No. 79.02, Vol. 1, 38 pp. Unpublished.

Zappalorti, R. T.; Farrell, R. F. 1980. An ecological study of the bog turtle, *Clemmys mühlenbergii*, Schoepff (Reptil, Testudines, Emydidae), in New Jersey, Pt. 3. Report to the New Jersey Dept. of Environ. Protection, Endangered and Nongame Spec. Proj., Federal Aid Prog. and Herpetological Associates. HA Rept. No. 80.01. Unpublished.

AGE/SIZE AT SEXUAL MATURITY: At 5 years and plastron length of 75 mm (Barton and Price 1955). From 6 to 8 years, at plastral length of 70 mm (Ernst 1977).

BREEDING PERIOD: Late April to early June.

EGG DEPOSITION: June to July, often in tussocks or on top of sphagnum in open, sunny areas on bogs (Zappalorti et al. 1979).

CLUTCH SIZE: 2 to 5, typically 2 to 3 (Zappalorti et al. 1979).

INCUBATION PERIOD: 7 to 8 weeks (Nemuras 1969).

EGGS HATCH: July to early September (Ernst and Barbour 1972:77-78). In northern locations, hatchlings may overwinter in the nest.

HOME RANGE/MOVEMENT: Average range was 1.28 ha for 19 individuals in Lancaster County, Pennsylvania (Ernst 1977). Ranging from 0.008 to 0.943 ha, traveling through wet runs (Barton 1957, cited in Ernst 1977:246). Average movement was 12 m between recaptures for a male; when displaced, the same individual moved 0.4 km in 1 day returning to initial point of capture (Ernst and Barbour 1972:79).

FOOD HABITS PREFERENCES: Omnivorous. Eats berries (20 percent), insects (80 percent), (Surface 1908:158), also slugs, earthworms, crayfish, frogs, snakes, nestling birds, seeds of pondweeds and sedges, snails, carrion; availability determines food consumption (Barton and Price 1955). Forages on land and under water.

Bog Turtle (Continued)

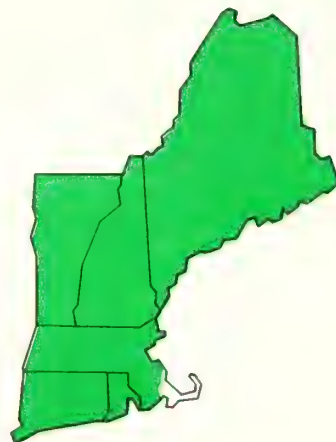
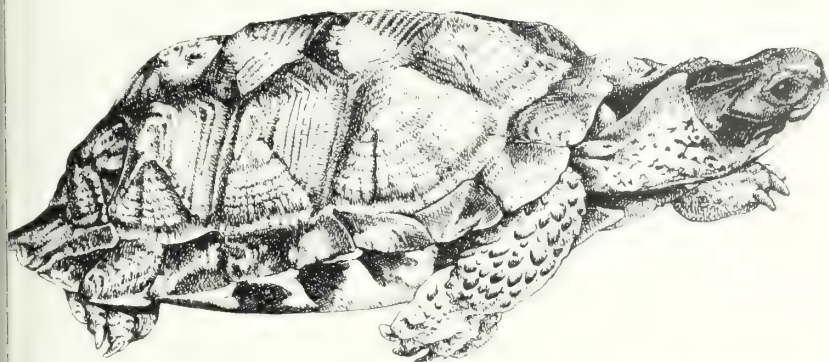
(*Clemmys muhlenbergii*)

COMMENTS: Formerly named Muhlenberg's turtle. May aestivate during dry summer months (Ernst and Barbour 1972:77). Seldom active during the hottest part of the day (Zappalorti and Farrell 1980). Overcollection of this species is a problem, and locality information should be reported with discretion to prevent exploitation. Formerly abundant; population decreases related to wetland drainage and fill.

KEY REFERENCES: Barton and Price 1955, Bury 1979, Ernst and Bury 1977, Zappalorti et al. 1979, Zappalorti and Farrell 1980.

Wood Turtle

Clemmys insculpta)



RANGE: Nova Scotia w. through the Great Lakes region to e. Minnesota. In the East extending s. to n. Virginia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Once common, population declining.

HABITAT: Frequents slow-moving meandering streams with sandy bottoms and overhanging alders (T. Graham, personal communication). Basks during morning hours along banks of streams. Disperses from water sources during summer months to fields, woods, and roadsides. Restricted to hardwood forest areas in New Jersey (Farrell and Zappalorti 1979);⁵ pine barrens area, Rhode Island (Tucker, personal observation).

Turns in fall to streams to hibernate in muddy banks and bottoms through late March to April. Have been found hibernating in holes in stream banks (T. Graham, personal communication), in decaying vegetation of woods and trout streams with deep pools (M. Klemens, personal communication). Will also use abandoned muskrat burrows; some use same hibernaculum each year (Farrell and Zappalorti 1979).

SOCIAL HABITAT REQUIREMENTS: Wooded river banks; open sandy nesting areas.

AGE/SIZE AT SEXUAL MATURITY: Seems to vary geographically and between individuals. In New Jersey, specimens at 165 mm carapace length, aged between 7 and 8 years were thought to be sexually mature (Harding and Epomer 1979). About 10 years and 160 mm carapace length in Michigan (Harding 1977).

⁵Farrell, R. F.; Zappalorti, R. T. The ecology and distribution of the wood turtle, *Clemmys insculpta* (LeConte), New Jersey, Pt. 1. (Preliminary report on a research contract between the New Jersey Dept. of Environ. Protection, Endangered and Nongame Species Proj., Nat. Audubon Soc. and Herpetological associates No. 79.03.) Unpublished.

BREEDING PERIOD: March, May, October (Ernst and Barbour 1972:82), when stream temperature reaches about 15°C (59°F) (Farrell and Zappalorti 1979).⁶ Mating occurs in shallow water.

EGG DEPOSITION: May to June. Eggs laid in prepared depressions in open areas with sandy soils or gravel, not necessarily near water.

CLUTCH SIZE: 4 to 12 eggs (Carr 1952:122), averages 8 to 9 (Farrell and Zappalorti 1979) 5 to 18 in Michigan (Harding 1977).

INCUBATION PERIOD: 77 days (Allen 1955); 58 to 69 days in laboratory (Farrell and Zappalorti 1980).

EGGS HATCH: August to October. Hatchlings may overwinter in the nest in northern parts of range.

HOME RANGE/MOVEMENT: One male moved an average of 90 m for three recaptures, one female was found 15 m from initial capture point (Ernst and Barbour 1972:83). Exhibited fidelity to a particular stream or brook in New Jersey (Farrell and Zappalorti 1979), and Pennsylvania (Strang 1983); mean home range was 447 m for 10 individuals in lowland forest.

FOOD HABITS/PREFERENCES: Omnivorous. Eats young vegetation, grass, moss, mushrooms, berries, insects and their larvae, worms, slugs, snails (Surface 1908:161-162); also carrion, tadpoles, frogs, and fish. Feeds in water or on land.

⁶Farrell, R. F.; Zappalorti, R. T. An ecological study of the wood turtle, *Clemmys insculpta* (LeConte), (Reptilia, Testudines, Emydidae) in northern New Jersey, Pt. 2. (Report to the New Jersey Dept. of Environ. Protection, Endangered and Nongame Species Proj., Herpetological Assoc. Rep. No. 80.02.) Unpublished.

Wood Turtle (Continued)

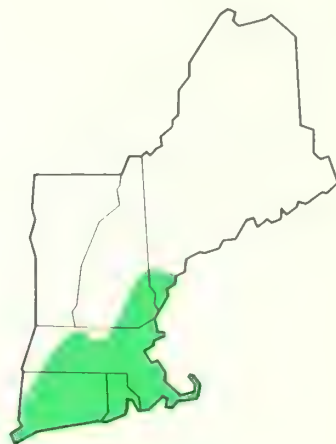
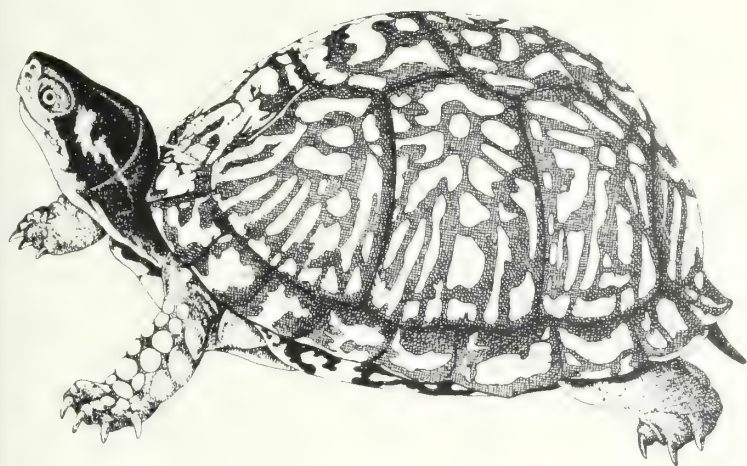
(Clemmys insculpta)

COMMENTS: Formerly thought to be one of the most terrestrial turtles, actually found equally in water and on land. Lives in large groups or colonies (Farrell and Zappalorti 1979). Diurnal. Development of wooded river banks and widespread commercial collection are factors contributing to population decline. Not tolerant of pollution. Young not often encountered.

KEY REFERENCES: Ernst 1972b, Farrell and Zappalorti 1979.

Eastern Box Turtle

Terrapene c. carolina)



RANGE: Southeastern Maine and the Thousand Island region of New York w. to the Mississippi River, c. Illinois and s. to n. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common, more abundant farther south; declining in many areas.

HABITAT: Woodlands, field edges, thickets, marshes, stream banks; typically found in well-drained forested bottomland (Stickel 1950). Young semiaquatic. Has been observed swimming in slow-moving streams and ponds. Found chiefly in open deciduous forests (N. Green, personal observation). Also found on mountain slopes in Massachusetts (T. Tynning, personal communication). During hot dry weather may rest in mud or water or burrow under logs or decaying vegetation for extended periods. When not active, rests in brush piles and thickets. Hibernates from depths of several inches to 2 feet (0.6 m) below surface in loose soil, decaying vegetation, mud, or in stream banks from late fall to April.

SOCIAL HABITAT REQUIREMENTS: Old fields, powerline clearings, ecotones with sandy soils favored (M. Klemens, personal communication).

AGE/SIZE AT SEXUAL MATURITY: 4 to 5 years in Kentucky, (Ernst and Barbour 1972:43), 5 to 10 years in Indiana (Linton 1972:165).

BREEDING PERIOD: After emerging from hibernation in April, sometimes continuing to fall. Females may lay viable eggs for up to 4 years after mating (Ewing 1943).

EGG DEPOSITION: June to July in the Northeast. Females often seen crossing roads in Massachusetts and New Jersey during nesting season (T. Graham, personal communication).

CLUTCH SIZE: 3 to 8 eggs, average 4 to 5.

INCUBATION PERIOD: 87 to 89 days (Allard 1935, cited in Carr 1952:146).

EGGS HATCH: August to September, hatchlings may overwinter in nest.

HOME RANGE/MOVEMENT: From 150 to 750 feet (45.7 to 228.4 m); 12 individuals averaged movement of 390 feet (118.8 m) on Long Island (Breder 1927). For 62 individuals in mixed woodlands and open habitat on Long Island, average range was less than 750 feet (228.4 m) as reported by Nichols (1939). Stickel (1950) reported average diameter of 350 feet (106.6 m) in Maryland. One individual was found within 0.25 miles (0.4 km) from point of release 60 years previously (Allen 1868, cited in Babcock 1919:412). Maintains same home range for many years, occasionally leaves normal home range for random wandering of egg laying (Stickel 1950). Homing instinct displayed by 45 out of 60 turtles (Nichols 1939).

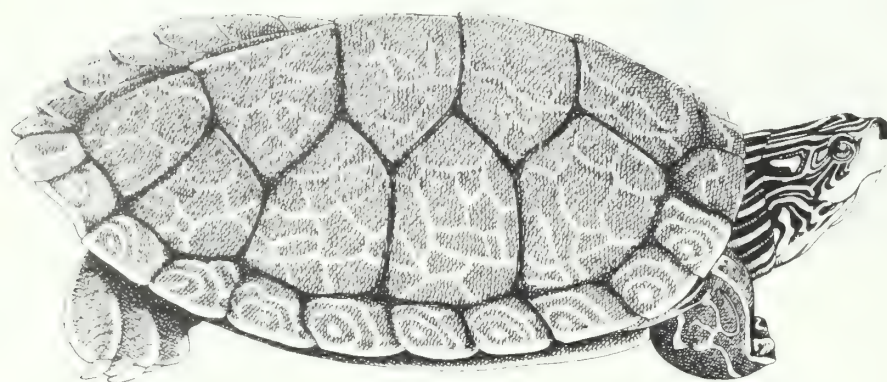
FOOD HABITS/PREFERENCES: Younger individuals chiefly carnivorous, older individuals more herbivorous. Food items include animals such as earthworms, slugs, snails, insects and their larvae, particularly grasshoppers, moths and beetles; crayfish, frogs, toads, snakes, and carrion; vegetable matter such as leaves, grass, bugs, berries, fruits and fungi.

COMMENTS: Terrestrial and diurnal. Digs into leaf litter toward end of day. Bisection of habitat by roads can reduce or destroy populations. The reversion of much agricultural land to woodland may be a beneficial change to populations (M. Klemens, personal communication). Estimated age at full growth is 20 years. May live 60 to 80 years (Nichols 1939). Some individuals may live more than 100 years (Graham and Hutchinson 1969).

KEY REFERENCES: Carr 1952, Ernst and Barbour 1972, Stickel 1950.

Map Turtle

(*Graptemys geographica*)



RANGE: Lake Champlain to the Great Lakes w. to the Mississippi drainage to e. Minnesota, s. to Louisiana and nw. Georgia. Along Susquehanna drainage. Introduced to Delaware River. Nests as far south as Poughkeepsie, Dutchess County, New York.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon and of limited distribution.

HABITAT: Aquatic, inhabiting rivers and lakes. Prefers large bodies of water with soft bottoms and aquatic vegetation. Hibernates in mud or shallow water from late fall to early spring. May be active on or under ice. Gregarily basks on logs or rocks or along beaches and grassy shores. In Michigan, found in riffles of pebble-bottom streams that have interspersed, deeper, muddier pools (M. Klemens, personnel communication). Move from shallow bays to nesting areas and reenter bays to overwinter in Quebec (Gordon 1980).

SPECIAL HABIT REQUIREMENTS: Water bodies with muddy or soft bottom substrate.

AGE/SIZE AT SEXUAL MATURITY: Females at 7.5 inches (190.5 mm) and larger (Newman 1906, cited in Pope 1939:169).

BREEDING PERIOD: April and autumn (Ernst and Barbour 1972:110).

EGG DEPOSITION: May to July, peak mid-June. Nesting season begins in mid-June in Quebec and averages 2 weeks in duration (Gordon 1980). Nests made in soft sand or soil away from beaches.

CLUTCH SIZE: 10 to 16 eggs (Cahn 1937), typically 12 to 14 eggs. More than one clutch may be laid.

EGGS HATCH: Late August to early September (Carr 1952:199), some may overwinter in the nest.

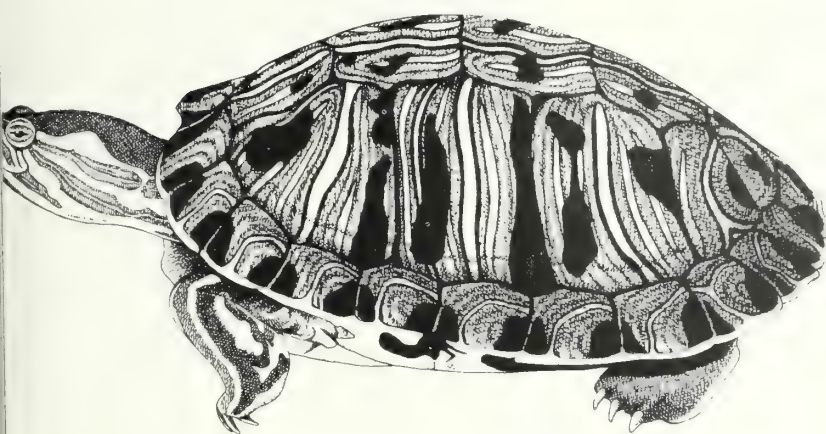
HOME RANGE/MOVEMENT: Unreported.

FOOD HABITS/PREFERENCES: Aquatic feeders—snails and clams are the major components of the diet; other small mollusks, crayfish, vegetable matter, fish, insects, and carrion are eaten (Carr (1952: 199).

KEY REFERENCES: Evermann and Clarke 1916, Newman 1906.

Red-eared Slider

(*Pseudemys scripta elegans*)



RANGE: Central Ohio w. to se. Iowa, s. into New Mexico, Texas, Alabama and w. Tennessee. Feral in parts of the Southeast.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Ponds, shallow areas of lakes, creeks and drainage ditches. Hibernates when water temperature drops below 10°C (50°F). Sometimes occupies muskrat mounds or hollow stumps.

SPECIAL HABITAT REQUIREMENTS: Quiet water with muddy bottom, abundant vegetation, projecting substrate, such as logs or rocks for basking.

CLUTCH SIZE AT SEXUAL MATURITY: Plastron length for males 100 to 110 mm, for females 150 to 195 mm.

SPAWNING PERIOD: Unreported.

EGG DEPOSITION: April to mid-July. Females may be capable of reproducing for 40 to 50 years. Average longevity may be 50 to 75 years (Cagle 1950). Female excavates a hole in earth, deposits eggs and seals hole with mud and debris. May move a mile (1.6 km) from water to find suitable nest site.

CLUTCH SIZE: 2 to 22, typically 5 to 10. 1 to 3 clutches per season.

INCUBATION PERIOD: 68 to 70 days (*Pseudemys scripta elegans* incubated in laboratory, Cagle 1950).

EGGS HATCH: July 1 to mid-September (Illinois and Louisiana).

HOME RANGE/MOVEMENT: Most sliders (n = 1,006) inhabiting a drainage ditch in Mississippi River floodplain remained within one-half mile (0.8 km) of release site (Cagle 1944:24).

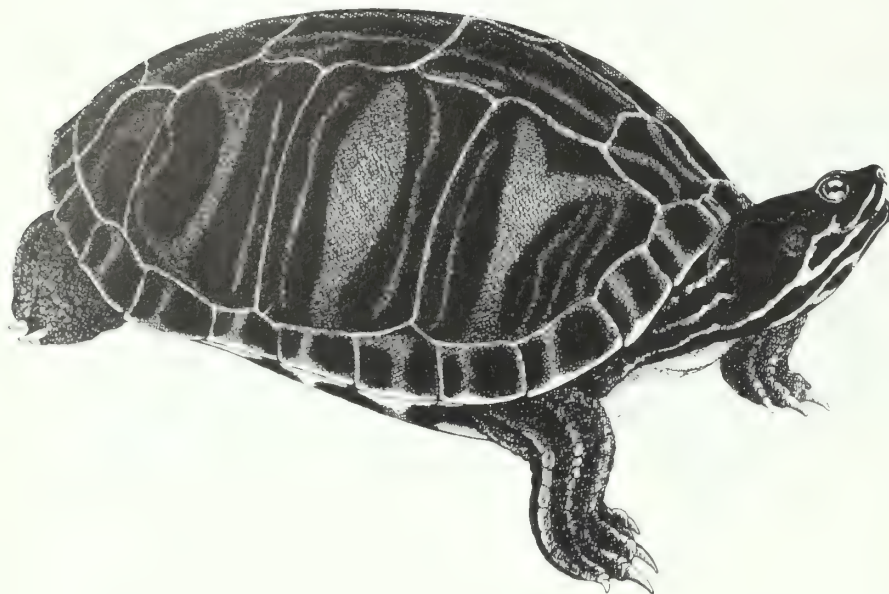
FOOD HABITS/PREFERENCES: Omnivorous. Take tadpoles, crayfish, mollusks, large larvae of aquatic insects, small fish (Cahn 1937).

COMMENTS: Possibly feral in Maryland (Cooper 1959). Active from late April until October in Illinois. Highly aquatic, avoids land except when laying eggs. Aestivates in mud when temperatures exceed 31°C (89°F) (Cagle 1950).

KEY REFERENCES: Cagle 1950, Cahn 1937, Cooper 1959, Webb 1961.

Plymouth Redbelly Turtle

(*Pseudemys rubriventris bangsi*)



RANGE: Plymouth County, Massachusetts. Recently, skeletal remains and a shell found in Ipswich, Essex County, Massachusetts (Graham 1982).

RELATIVE ABUNDANCE IN NEW ENGLAND: Endangered (federal list).

HABITAT: Ponds of different sizes in Plymouth County. Frequents shallow coves (Graham 1971a).

SPECIAL HABITAT REQUIREMENTS: Muddy-bottomed shallows with abundant aquatic vegetation, especially milfoil (*Myriophyllum*) and bladderwort (*Utricularia*) (Graham 1980).

AGE/SIZE AT SEXUAL MATURITY: Probably not reached during first 9 years (Graham 1971a). Average life span estimated at 40 to 55 years (Graham 1980).

BREEDING PERIOD: Probably early spring and fall (T. Graham, personal communication).

EGG DEPOSITION: Mid-June to early July. Prefer to nest in disturbed sites (T. Graham, personal communication).

CLUTCH SIZE: Range 12 to 17 eggs — average 14.5 (T. Graham, personal communication).

EGGS HATCH: Probably September, fall (T. Graham, personal communication), July if they overwinter. Average hatching time of 75 days for 17 eggs incubated in a laboratory at 29°C (84°F) (Graham 1971b). If hatchlings overwinter, emerge during the following July.

HOME RANGE/MOVEMENT: Unknown but wanders on land especially during fall and late spring. Found 0.5 to 2.0 miles (0.8 to 3.2 km) from water on occasion. Significance of wandering unknown (T. Graham, personal communication).

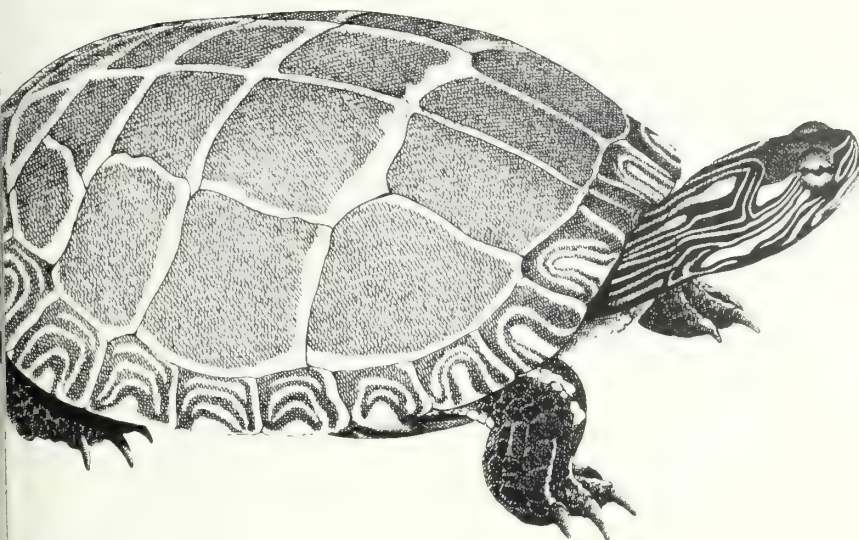
FOOD HABITS/PREFERENCES: Primarily herbivorous, feeding mainly on milfoil, also feeds on bladderwort (Graham 1980) and arrowhead (*Sagittaria*) (Graham 1971a). Dietary shift to crayfish in fourth season (Graham 1971a).

COMMENTS: Basks during early morning hours on elevated sites or in water by floating or resting on weed mats (Graham 1980). Discovered in Plymouth, Massachusetts, in 1869 (Lucas 1916). Population estimate about 200 to 300 in Plymouth County (T. Graham, personal communication).

KEY REFERENCES: Graham 1971a, 1971b, 1980; Lazell 1976.

Eastern Painted Turtle

Chrysemys p. picta)



RANGE: Nova Scotia to ne. New York, to Cape Hatteras inland to e. Alabama. In the Northeast merges with range of the Midland painted turtle.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common, often abundant.

HABITAT: Quiet, shallow ponds, marshes, woodland swamps, rivers, lake shores, wet meadows, bogs, and slow-moving streams. Sometimes in brackish tidal waters, salt marshes (Pope 1939:183). Stagnant and polluted waters are sometimes inhabited (Smith 1956:150). When in water usually remains in submerged vegetation. Basks on small hummocks, logs, rocks, sometimes congregating in large groups. Hibernates by burrowing into mud or decayed vegetation of pond bottoms.

SPECIAL HABITAT REQUIREMENTS: Aquatic habitat.

SIZE AT SEXUAL MATURITY: Correlated with size, in Michigan males exceeded 81 mm plastron length, females ranged from 110 to 120 mm (Gibbons 1968a).

SPawning PERIOD: March to mid-June and fall (Gibbons 1968a). Peak in April in Connecticut (Carr 1952:218).

EGG DEPOSITION: May to July. Nest sites within a few feet of water (Cahn 1937, cited in Smith 1961:140), or up to one-half mile away (T. Tyning, personal communication).

CLUTCH SIZE: 2 to 11 eggs, females may lay 2 clutches (Gibbons 1968a), typically 5 to 6 eggs.

INCUBATION PERIOD: 72 to 80 days (Ernst and Barbour 1972:143). 63 days (Lynn and vonBrand 1945). Hatchlings from late clutches may overwinter in the nest. Nests are often destroyed by raccoons and skunks.

EGGS HATCH: Late August to early September, in Connecticut (Finneran 1948).

HOME RANGE/MOVEMENT: Displays short-distance homing ability; fewer than 15 percent moved more than 100 m in a marsh in Michigan (Gibbons 1968a). Average distance traveled was 112 m in a shallow bay of a Wisconsin lake; 70 percent of the turtles did not travel. Individuals may remain in the same locality for years if conditions are favorable (Pearse 1923).

FOOD HABITS/PREFERENCES: Aquatic insects, snails, small fish, tadpoles, mussels, carrion, and aquatic plants taken by foraging along the bottom. Diet usually about 50 percent vegetation.

COMMENTS: Diurnal. Emerges from hibernation in late March or early April in Massachusetts (Graham 1971a).

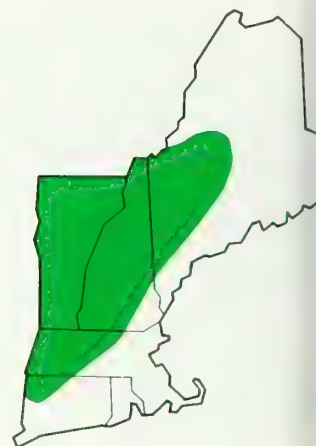
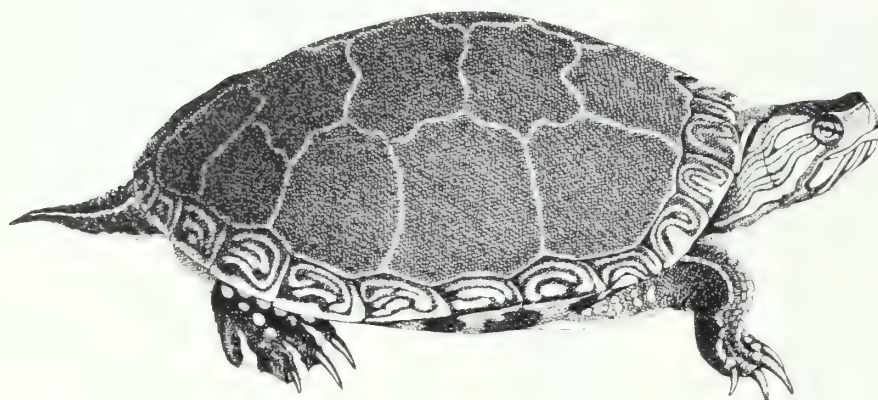
Chrysemys p. picta and *C. p. marginata* intergrade in the Northeast. Intergrades accounted for 79 percent of 89 individuals examined from the Delaware Water Gap in New Jersey (Stein 1980).⁷

KEY REFERENCES: Carr 1952, Ernst 1971, Ernst and Barbour 1972, Gibbons 1968a.

⁷Stein, R. J. Species account form for: Second symposium on endangered and threatened plants and animals of New Jersey. Unpublished.

Midland Painted Turtle

(*Chrysemys picta marginata*)



RANGE: New Hampshire, s. Quebec and Ontario to e. Wisconsin. Through c. Illinois s. to Tennessee. Vermont and New York s. to w. of the Shenandoah River.

RELATIVE ABUNDANCE IN NEW ENGLAND: Intergrades with *C. p. picta* are abundant.

HABITAT: Quiet water, preferably shallow areas with dense vegetation. Tolerant of some industrial pollution. Basks in groups on sunlit logs. Sometimes found away from water. Usually hibernates in muddy bottoms of ponds, but has been reported active yearlong.

SPECIAL HABITAT REQUIREMENTS: Aquatic habitats.

AGE/SIZE AT SEXUAL MATURITY: 5 years for males, 6 to 7 years for females (Pope 1939:185).

BREEDING PERIOD: Early spring after emerging from hibernation; fall matings have been reported.

EGG DEPOSITION: June to July. Eggs often laid in high banks.

CLUTCH SIZE: 3 to 10 eggs, average 5 to 8.

EGGS HATCH: Hatchlings emerge in September or the next spring (Smith 1961:140).

HOME RANGE/MOVEMENT: Average summer movement within a pond about 90 m. Movements have been divided into three types: initial emigration in the spring of 63 to 144 m from hibernation ponds to other ponds with mats of

floating vegetation; late summer movements of 86 to 90 m, back to hibernation ponds; and late autumn movements of 88 to 130 m to deep water areas in Michigan (Sexton 1959). Sixty percent of the individuals studied in a Michigan lake exhibited homing behavior (Williamson 1952).

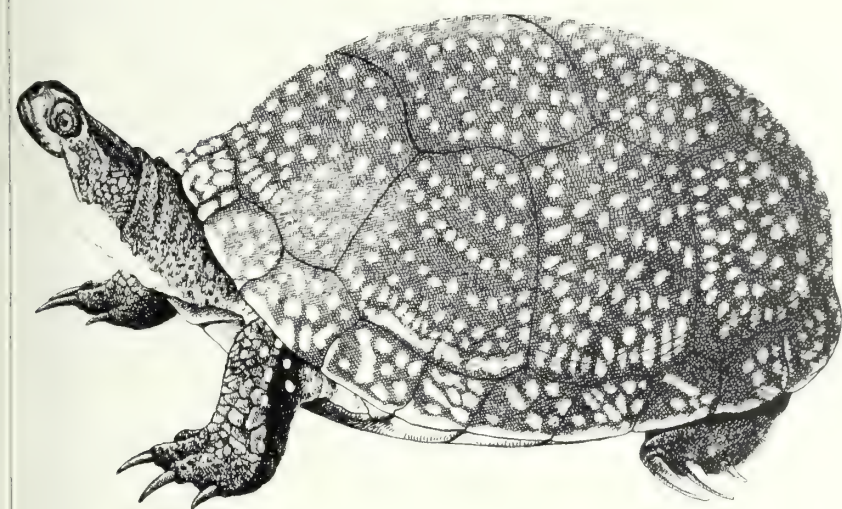
FOOD HABITS/PREFERENCES: Aquatic vascular plants, seeds, algae, and invertebrates including crustaceans, mollusks, insects and their larvae, and worms. Also take carrion, fish, and frogs. Aquatic plants accounted for more than 60 percent of the diet and insects about 10 percent in Michigan (Lagler 1943).

COMMENTS: In New England there are no Midland turtle populations *per se*. Individuals are part of an intergrade swarm. Information provided in this account is based on references for *Chrysemys picta marginata* where intergrades do not occur. In New England, *Chrysemys picta marginata* and *C. p. picta* life history and habitat information are the same (M. Klemens, personal communication). Diurnal.

KEY REFERENCES: Carr 1952, Sexton 1959, Smith 1961.

Blanding's Turtle

Emydoidea blandingii)



RANGE: Scattered colonies in New York, New Hampshire, and e. Massachusetts. Southern Quebec across the Lake States to c. Minnesota, s. to Iowa and c. Illinois. Spotted occurrence from Nova Scotia to Ohio.

RELATIVE ABUNDANCE IN NEW ENGLAND: Populations localized and distribution spotty throughout its range (McCoy 1973:136.1). Generally scarce to rare, locally abundant in Massachusetts (Lazell 1972). An endangered species in Canada.

HABITAT: Shallow waters preferred; marshes, bogs, wetlands, ponds, swamps, also in protected coves and inlets of large lakes with abundant aquatic vegetation. May wander overland. Basks on logs, stumps, banks. Active in winter or hibernates in mud or debris.

SPECIAL HABITAT REQUIREMENTS: Shallow waters with soft muddy bottoms and aquatic vegetation.

AGE/SIZE AT SEXUAL MATURITY: During 12th year for males with a plastron length of 181 to 190 mm, Massachusetts (Graham and Doyle 1977); males 131 to 190 mm in Michigan (Gibbons 1968b). Size differences between these two populations probably due to differences in food quality and availability (Graham and Doyle 1977).

REEDING PERIOD: Early spring through October, most often from March to May (Ernst and Barbour 1972:181). Peak in late April (T. Graham, personal communication).

EGG DEPOSITION: June to July. Nests made in sandy soils of upland areas.

CLUTCH SIZE: 6 to 11 eggs (Carr 1952:136), typically 8 to 9 eggs, clutches of 9, 13, and 16 eggs for Massachusetts females (T. Graham, personal communication). Clutch of 17 for a July nesting female (Graham and Doyle 1979). Two clutches may be laid each season.

INCUBATION PERIOD: Unreported.

EGGS HATCH: Autumn or next spring.

HOME RANGE/MOVEMENT: Less than 100 m for 4 individuals in a marsh in sw. Michigan (Gibbons 1968b).

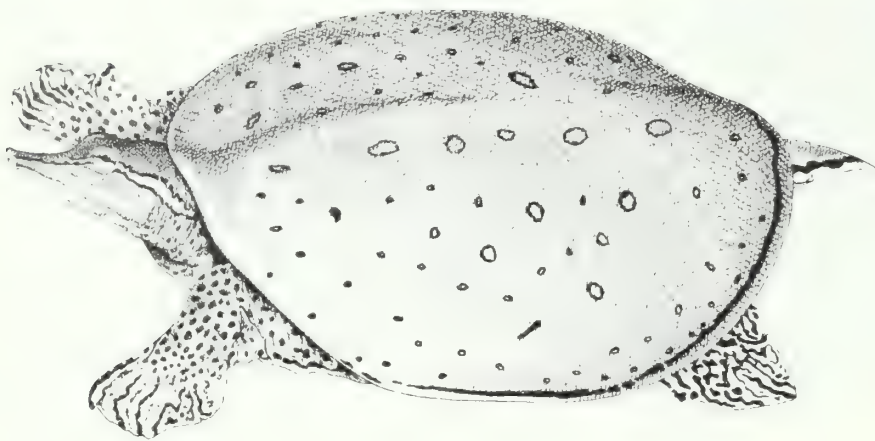
FOOD HABITS/PREFERENCES: Crustaceans, insects, mollusks, fish, carrion, aquatic plants, succulent shoots, and berries. Crustaceans and crayfish account for about 50 percent of diet, insects more than 25 percent, and other invertebrates and vegetable matter 25 percent (Lagler 1943).

COMMENTS: Escaped individuals found in Connecticut (Lamson 1935). Primarily diurnal. In Michigan found in rivers (M. Klemens, personal communication).

KEY REFERENCES: Gibbons 1968b, Graham and Doyle 1977, 1979, McCoy 1973.

Eastern Spiny Softshell

(*Trionyx s. spiniferus*)



RANGE: Western New York across the Great Lakes states to the Mississippi River, n. Wisconsin s. to the Tennessee River extending e. to c. Pennsylvania. A disjunct colony occupies the Champlain Valley. Introduced into the Maurice River system of New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Aquatic, inhabiting large river systems. Also found in lakes and ponds. Intolerant of pollution from sewage, industrial, or chemical wastes (Minton 1972:191). Basks on sand bars, mud flats, grassy beaches, but will use logs, rocks, and other objects when sandy or muddy banks are unavailable (Williams and Christiansen 1982). Hibernates beneath 2 to 3 inches (5.1 to 7.6 cm) of river bottom mud from October to April in the north.

SPECIAL HABITAT REQUIREMENTS: Shallow muddy bottoms for burrowing. Some aquatic vegetation essential (N. Green, personal observation).

AGE/SIZE AT SEXUAL MATURITY: Females with plastron length of 180 to 200 mm, males at 90 to 100 mm.

BREEDING PERIOD: April or May.

EGG DEPOSITION: May to August. Eggs laid in sandy soil or gravel beds near water's edge.

CLUTCH SIZE: Typically 12 to 18, with a range of 4 to 32 eggs (Ernst and Barbour 1972:264).

EGGS HATCH: August to October or hatchlings overwinter in nest.

HOME RANGE SIZE: Unreported.

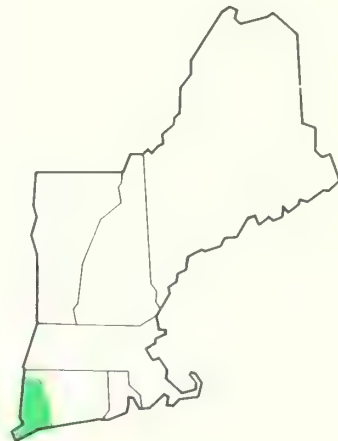
FOOD HABITS/PREFERENCES: Chiefly carnivorous. Crustaceans, fish and insects are the major food items with tadpoles, frogs, mollusks, and fish eaten less frequently; vegetation and other plant materials also consumed. Primarily benthic feeders (Williams and Christiansen 1982).

COMMENTS: Somewhat nocturnal.

KEY REFERENCES: Ernst and Barbour 1972, Minton 1972, Webb 1973.

Five-lined Skink

(*Eumeces fasciatus*)



RANGE: Southern end of Lake George, New York and se. New York s. to n. Florida, w. to c. Texas. Northern limit from Pennsylvania, Ontario to c. Wisconsin and N. Missouri.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare in the Northeast through se. Connecticut. Records for Massachusetts are from Barre (Storer 1840:19) and New Bedford (Allen 1870:260).

HABITAT: Mesic wooded areas, open or moderately dense with ground cover. Most abundant around old buildings and open woods. Frequently in damp spots, under logs, rock piles, leaf litter, sawdust piles. Suns for brief periods on warm days (Smith 1946:349). Found on open talus slopes in mixed deciduous woodlands, New York. Primarily terrestrial, but will climb snags to find insects. Hibernates from October until mid-March in decaying logs or below the frost line, underground or under large rocks.

SPECIAL HABITAT REQUIREMENTS: Open woods with logs and slash piles.

AGE/SIZE AT SEXUAL MATURITY: After second hibernation.

FEEDING PERIOD: May.

EGG DEPOSITION: Typically in June or July, 6 to 7 weeks after breeding (Smith 1956:193). Eggs laid under rocks, logs, in rotted stumps, in loose soil. Females usually guard eggs during incubation (Conant 1975:122). Ad-

dled eggs are ingested; it has been suggested that brooding females remove these eggs to reduce chances of predation (Groves 1982).

CLUTCH SIZE: 4 to 20 eggs (Barbour 1971:209), typically 9 to 12. Younger individuals lay fewer eggs (Fitch 1970).

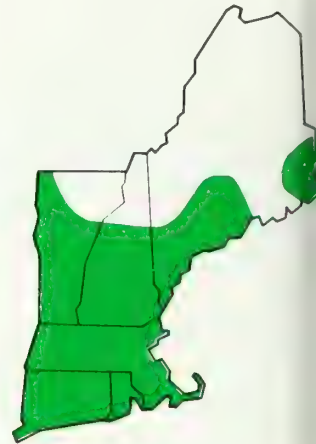
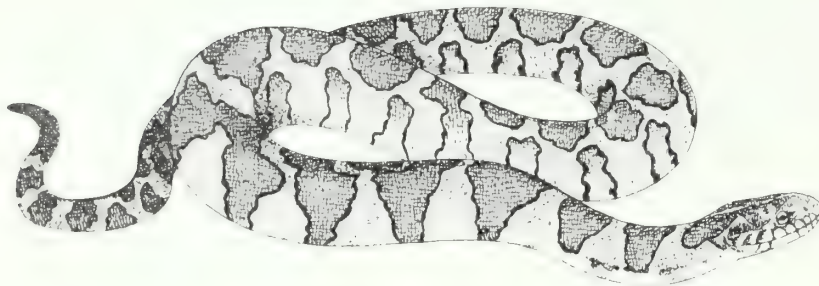
HOME RANGE/MOVEMENT: Males home-range diameter about 90 feet (27.4 m), females about 30 feet (9.1 m), in e. Kansas (Fitch 1954, cited in Minton 1972:210). Individuals may remain in same home range or move after emerging from hibernation.

FOOD HABITS/PREFERENCES: Primarily insects and spiders, also snails, grubs, small vertebrates, including young mice. Lizards occasionally eaten; will eat its own shed skin.

KEY REFERENCES: Barbour 1971; Smith 1946, 1956.

Northern Water Snake

(*Nerodia s. sipedon*)



RANGE: Southern Maine, s. Ontario to n. Wisconsin, s. through Kansas to e. Colorado, n. Oklahoma to c. Indiana, Kentucky, and Tennessee, e. to North Carolina and New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant in suitable habitat.

HABITAT: Aquatic and semiaquatic habitats. Common around spillways and bridges where rocks provide cover, uncommon in deeply shaded woodland swamps and ponds, probably due to lack of basking sites (M. Klemens, personal communication). Found in the vicinity of rivers, brooks, wet meadows, ponds, swamps, bogs, old quarries. Inhabits salt or fresh water (Wright and Wright 1957:513), absent from heavily polluted waters. Prefers still or slow-moving water. Hibernates in crevices of rocky ledges, or in banks adjacent to water habitat.

SPECIAL HABITAT REQUIREMENTS: Branches or logs overhanging the water, or boulders of dams and causeways in reservoirs (T. Tyning, personal communication).

AGE/SIZE AT SEXUAL MATURITY: Males 635 to 1,148 mm, females at 650 to 1,295 mm (Wright and Wright 1957:513).

BREEDING PERIOD: April to May and early fall.

YOUNG BORN: August to early October, usually during the last half of August. Viviparous.

NO. OF YOUNG: 10 to 76 young, average 20 to 40. Large females have larger litters.

HOME RANGE/MOVEMENT: One individual moved 38 feet (115.8 m) along a river after 2 years (Stickel and Cope 1947). In large ponds at an Indiana fish hatchery 80 percent were recaptured in the same pond, 89 percent were in the same pond or an adjacent pond. Snakes along streams had larger home ranges (Fraker 1970).

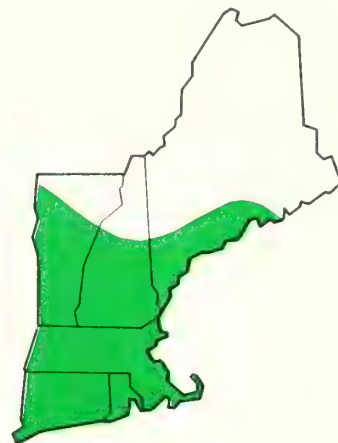
FOOD HABITS/PREFERENCES: Cold-blooded vertebrate fish account for 61 percent of food items, frogs and toads 21 percent, salamanders 12 percent; also insects, crayfish, recently dead fish (Uhler et al. 1939). Fish account for more than 95 percent of diet (Raney and Roelck 1947). May occasionally take shrews and mice.

COMMENTS: Frequently found basking. Active both day and night.

KEY REFERENCES: Schmidt and Davis 1941, Wright and Wright 1957.

Northern Brown Snake

(*Liasis fuscus dekayi*)



RANGE: Eastern United States from s. Maine and s. Canada w. to Michigan, s. to South Carolina. Range overlaps that of the Midland brown snake. Reported from Somerset Co., Maine, October 1984 (C. Baumgartner and R. Kmecek, personal communications).

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Ubiquitous, found in urban and rural areas, dry or moist situations, vacant lots, parks, trash piles. May be abundant along railroad tracks (T. Tynning, personal communication). In the wild, found in damp woods, swamps, clearings, bogs, roadsides, open fields. Hides under stones, banks, logs, brush piles, leaves. Rare in old-growth forests (J. Lazell, personal communication). Hibernates in large groups from October to November until March or April; may use ant hills or abandoned mammal burrows.

AGE/SIZE AT SEXUAL MATURITY: At 2 years (Noble and Clausen 1936).

BREEDING PERIOD: Late March to April and possibly in the fall.

YOUNG BORN: Late July to August. Gestation period of 105 to 113 days (Clausen 1936). Viviparous.

NUMBER OF YOUNG: 3 to 27 young (Fitch 1970), typically 14.

HOME RANGE/MOVEMENT: Average daily movement of 10 to 15 feet (3.0 to 4.6 m) on Long Island. Thirteen of 32 individuals displayed homing behavior (Noble and Clausen 1936).

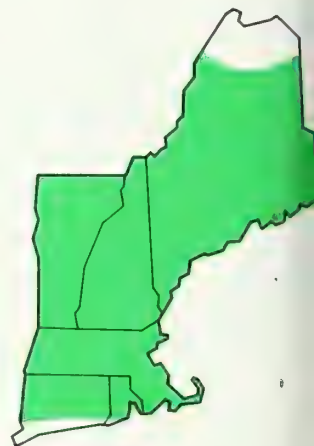
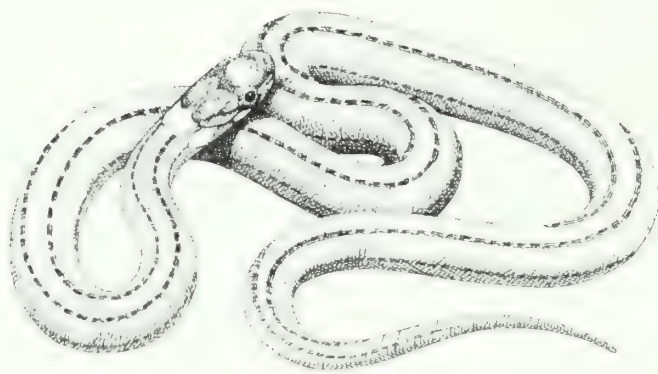
FOOD HABITS/PREFERENCES: Slugs, snails, earthworms, insects, minnows, and tiny toads are occasionally eaten.

COMMENTS: Formerly DeKay's snake. Commonly found in aggregations throughout the year (Noble and Clausen 1936). May seem to be scarce during July and August when it moves down into soil to lower temperature zones. Degree of fossorial tendency varies with microhabitat temperature preference (Elick et al. 1979). Active evening to early morning; one of the few New England snakes that is active at night.

KEY REFERENCES: Schmidt and Davis 1941, Wright and Wright 1957.

Northern Redbelly Snake

(*Storeria o. occipitomaculata*)



RANGE: Nova Scotia to s. Manitoba, s. to e. Texas, Georgia, and throughout the Eastern United States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally abundant.

HABITAT: Moist woods, hillsides, sphagnum bogs, upland meadows and valleys. Found under surface debris, also around abandoned buildings. Occurs at elevations from sea level to mountains. Prefers woodlands: pine, oak-hickory, aspen, hemlock groves (Wright and Wright 1957:717). More frequently found in upland woody ridges. Occasionally found in damp meadows, marshy areas, swamp and bog edges. Hibernates from fall to March or April. Active through mid-October in Connecticut (M. Klemens, personal communication).

SPECIAL HABITAT REQUIREMENTS: Woodlands.

AGE/SIZE AT SEXUAL MATURITY: Males 182 to 359 mm, females 211 to 383 mm (Wright and Wright 1957:718), at 2 years (Blanchard 1937a).

BREEDING PERIOD: Probably after emerging from hibernation; a late summer or fall mating may also occur (Barbour 1971:287).

YOUNG BORN: August to September. Viviparous.

NO. OF YOUNG: 1 to 14 young (Blanchard 1937a), typically 7 to 8.

HOME RANGE/MOVEMENT: 1 adult found 100 feet (30.4 m)

from release point in Michigan after 7 days (Blanchard 1937a).

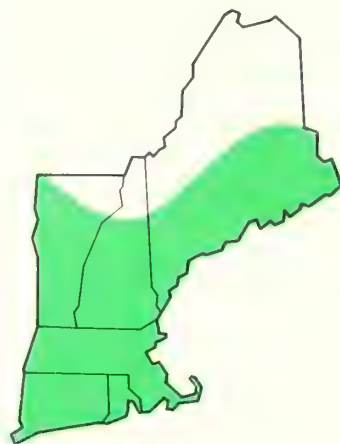
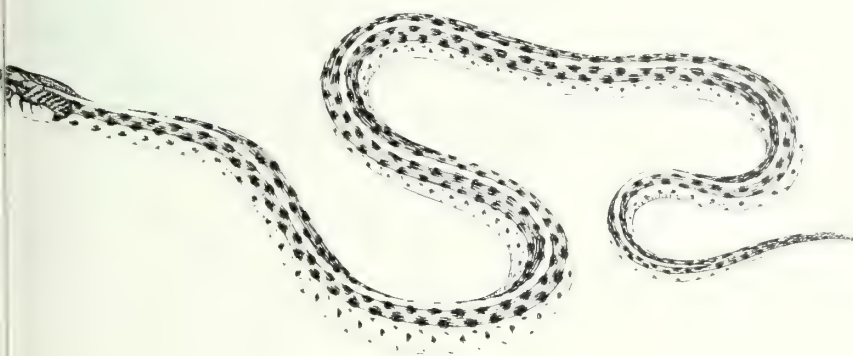
FOOD HABITS/PREFERENCES: Consumes slugs, earthworms, soft insects and larvae, sowbugs; occasional small salamanders.

COMMENTS: Has been found active at all times of day and evening. Degree of fossorial behavior varies (Elick et al. 1979). Young commonly mistaken for young ring-necked or Northern brown snakes.

KEY REFERENCES: Barbour 1971, Schmidt and Davis 1941, Wright and Wright 1957.

Eastern Garter Snake

Thamnophis s. sirtalis)



RANGE: Nova Scotia to e. Manitoba s. to e. Texas, and throughout the Eastern United States. Intergradation with *T. s. pallidula* occurs in n. New England (Fitch 1980:270.1).

RELATIVE ABUNDANCE IN NEW ENGLAND: Very abundant; most common and widespread snake.

HABITAT: Ubiquitous, terrestrial; found in moist areas, forest edges, stream edges, fence rows, vacant lots, swamps, overgrown yards. One specimen found under a rock in a stream through a dark hemlock grove (C. Klemens, personal communication). Found in almost all damp environments, from river bottoms to mountain elevations.

HIBERNATES: often gregariously, in holes, rock crevices, and, anthills, rotted wood, uprooted trees, house foundations, and sometimes partially or completely submerged under streambed rocks, from October to March or April. One of the earliest snakes to emerge from hibernation. Can survive the winter above frost line (Bailey 1949).

AGE/SIZE AT SEXUAL MATURITY: Females in second year, same males the second spring after birth (Carpenter 1952a). At 400 mm snout to vent length for males and 500 mm for females in Kansas (Fitch 1965:531).

FEEDING PERIOD: Concentrated in the first few warm days after emergence from hibernation in mid-March to May, also in fall before hibernation (Anderson 1965:169). Mates at or near hibernation site.

YOUNG BORN: July to early September. Gestation period of 3 to 4 months or longer in cooler climates (Blanchard and Blanchard 1942). Viviparous.

NO. OF YOUNG: 3 to 85 young, typically 14 to 40. Zehr (1962) found 12 to 13 young was the average in New Hampshire. Number of young correlated with size and age of female (Fitch 1965:558).

HOME RANGE/MOVEMENT: Approximately 5 acres (2.0 ha), most ranges were smaller in cutover agricultural fields in Indiana (Minton 1972). Activity range of about 2 acres (0.8 ha) in Michigan woodlands and open fields (Carpenter 1952a). Carpenter (1952b:250) defined activity range as an area covered by an animal in the course of its day-to-day existence, and which lacks definite home site or other center of activity. Home ranges of 35.0 acres (14 ha) for males and 22.2 acres (9.1 ha) for females were found in mixed habitat in Kansas (Fitch 1965:538). Many individuals migrate from hibernacula to summer ranges.

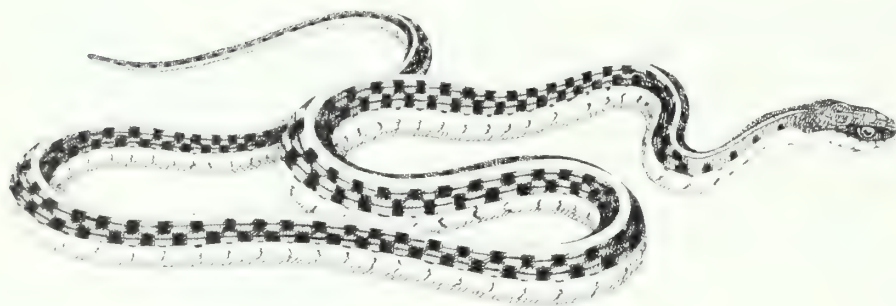
FOOD HABITS/PREFERENCES: Earthworms account for 80 percent of food items, also amphibians, carrion, fish, leeches, caterpillars, other insects, small birds, rodents (Carpenter 1952b); also slugs, other snakes, mollusks, crayfish, sowbugs (Hamilton 1951).

COMMENTS: Diurnal but sometimes active at night (Minton 1972:250). Seeks cover under objects on hot summer days. Pesticides have reduced local populations in New York (Gochfeld 1975).

KEY REFERENCES: Carpenter 1952b; Fitch 1965, 1980; Wright and Wright 1957.

Maritime Garter Snake

(*Thamnophis sirtalis pallidula*)



RANGE: Eastern Quebec extending to Alberta in discontinuous populations, s. to n. New Hampshire, New York and n. Michigan. Intergrades with *T. s. sirtalis* to w. and s. parts of range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Unreported.

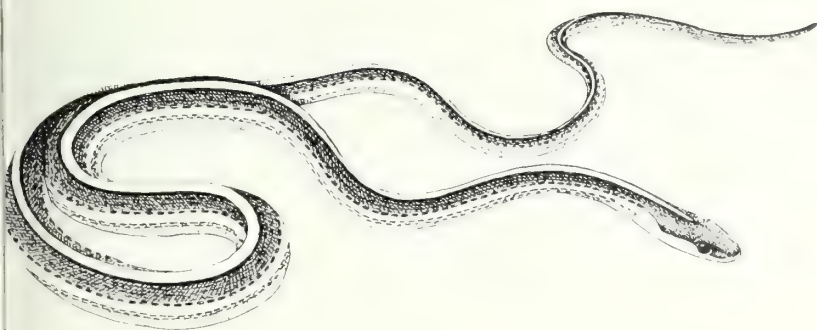
HABITAT: Found in mature hardwood stands, fir stands with mixed understory, and along forest roads in northern New Hampshire.

COMMENTS: Little information available on life history.

KEY REFERENCES: Bleakney 1959, Fitch 1980.

Eastern Ribbon Snake

(*Thamnophis s. sauritus*)



RANGE: Southern Maine to South Carolina and the Florida panhandle. Southern Indiana s. to e. Louisiana. Northern limits through s. Indiana to c. New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Generally common, but uncommon in Connecticut (M. Klemens, personal communication).

HABITAT: Semiaquatic, inhabiting stream edges, swampy areas, wet meadows, ponds, bogs, and ditches. Prefers areas with brushy vegetation at waters' edge for concealment. Also in damp or wet deciduous or northern pine forests. Seldom far from cover (Carpenter 1952b). May escape higher ground temperatures in summer by seeking shelter in shrubs or underground. Hibernates from October to March (Wright and Wright 1957:825).

SPECIAL HABITAT REQUIREMENTS: Mesic woodlands with aquatic habitat.

AGE/SIZE AT SEXUAL MATURITY: Females during second year (Carpenter 1952a), males 400 to 819 mm, females 411 to 900 mm (Wright and Wright 1957:825).

BREEDING PERIOD: After emergence from hibernation.

YOUNG BORN: Late July to September, viviparous.

NUMBER OF YOUNG: 3 to 20, typically 10 to 12.

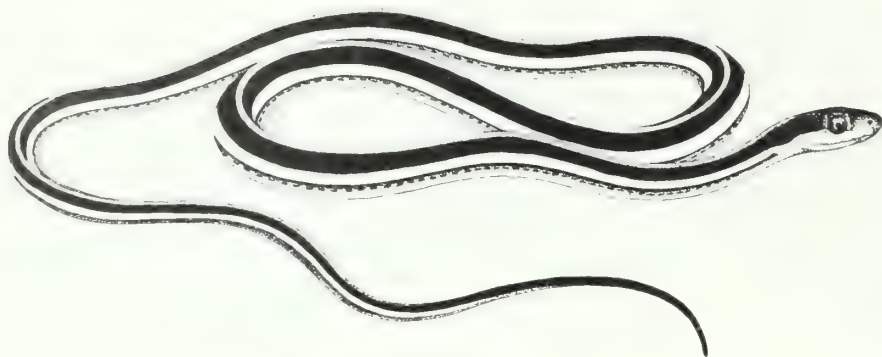
HOME RANGE/MOVEMENT: Average activity range of about 2 acres (0.8 ha), average distance traveled was approximately 280 feet (85.3 m) in open Michigan grassland and marsh (Carpenter 1952b).

FOOD HABITS/PREFERENCES: Frogs, toads, and salamanders account for 90 percent of prey items; usually smaller or metamorphosing individuals were taken; also mice, spiders, minnows, and some insects (Carpenter 1952b).

KEY REFERENCES: Carpenter 1952b, Rossman 1970.

Northern Ribbon Snake

(*Thamnophis sauritus septentrionalis*)



RANGE: Central Maine w. through nw. New England and s. Ontario to Michigan, s. to se. Illinois, Indiana, Ohio and n. Pennsylvania.

COMMENTS: Diurnal.

KEY REFERENCES: Conant 1975, Minton 1972.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: Sunny areas with low, dense vegetation that is near bodies of shallow quiet water. Damp meadows, grassy marshes, northern sphagnum bogs, borders of ponds, lakes and meandering creeks. Semiaquatic. Probably hibernates October to March (Minton 1972:260).

SPECIAL HABITAT REQUIREMENTS: Shallow, permanent water in open, grassy habitat.

AGE/SIZE AT SEXUAL MATURITY: Some females at almost 2 years (Carpenter 1952a).

BREEDING PERIOD: Probably spring and fall (Minton 1972:260).

YOUNG BORN: July to August (Minton 1972:260).

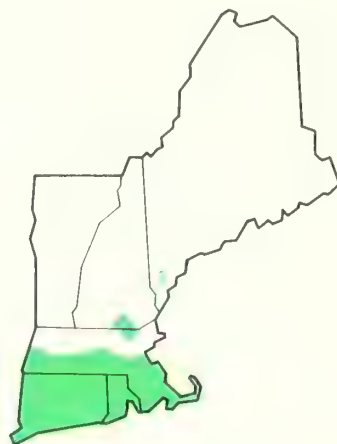
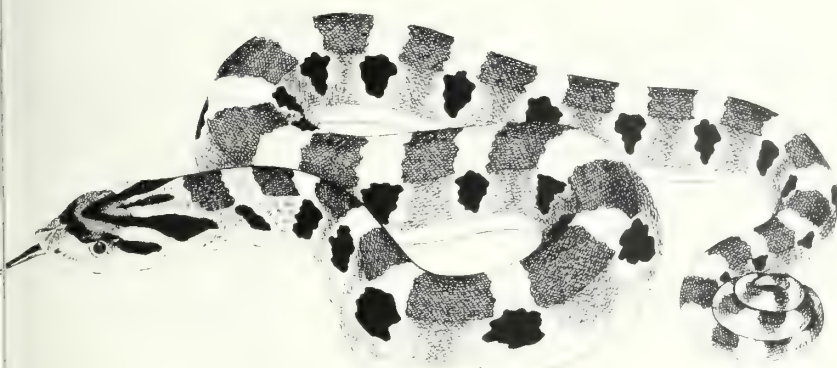
NO. OF YOUNG: 4 to 10 or 11 young (Minton 1972:260). Viviparous.

HOME RANGE/MOVEMENT: Unknown.

FOOD HABITS/PREFERENCES: Frogs, salamanders, fish. Captives will eat minnows. Brown (1979) noted that 93 percent of the food items in 21 stomachs were comprised of anurans.

Eastern Hognose Snake

(*Heterodon platyrhinos*)



RANGE: Cape Cod and c. Massachusetts w. to Ohio, s. to Ontario, c. Minnesota, and se. South Dakota, s. to c. Texas and s. Florida. Recently reported from Hillsborough, New Hampshire, in 1984 (unconfirmed). Also from Kittery, Maine (W. Chorman, personal communication).

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Where sandy soils predominate, such as beaches, open fields, dry, open pine or deciduous woods. Has been found on hillsides, farm fields, and around outbuildings. In Pennsylvania most frequently found in upland situations, intermountain and river valleys (McCoy and Bianculli 1966). Low-lying areas of Connecticut (M. Klemens, personal communication), and in marshy woodlands in the Albany Pine Bush in New York, and wooded creek bottomlands (M. Stewart, personal communication). Hibernates from late September to April or May under forest floor debris, stumps, or leaf piles (Wright and Wright 1957:308).

SPECIAL HABITAT REQUIREMENTS: Sandy soils, open woodlands.

AGE/SIZE AT SEXUAL MATURITY: Male 400 to 1,050 mm, females 450 to 1,200 mm (Wright and Wright 1957:309).

BREEDING PERIOD: April to May and probably fall (Fitch 1950).

EGG DEPOSITION: June to July. Eggs laid in earth, under or in pulpy wood of decaying logs.

CLUTCH SIZE: 4 to 61 eggs, typically 22 (Fitch 1970).

INCUBATION PERIOD: 39 to 60 days (Anderson 1965:185).

EGGS HATCH: July to September, peak in August.

HOME RANGE/MOVEMENT: After 5 months one individual in Maryland mixed habitat had moved 100 feet (30 m) (Stickel and Cope 1947).

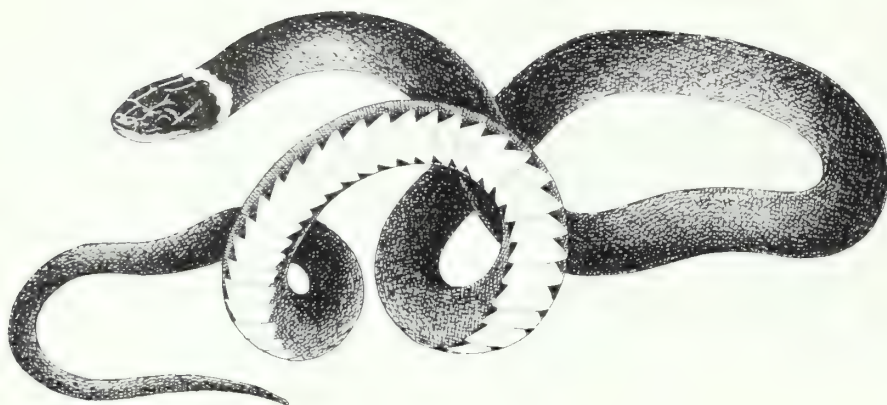
FOOD HABITS/PREFERENCES: Toads preferred, but frogs, fish, salamanders, insects, and worms are taken; rarely small birds and mammals and occasionally other snakes (Edgren 1955). Amphibians and reptiles accounted for 80 percent of the food items in 10 specimens in Virginia (Uhler et al. 1939).

COMMENTS: Diurnal. Fossorial habits, probably seek cover by burrowing (Edgren 1955). Particularly vulnerable to heavy herbicide and pesticide use. Defense behavior includes head rearing, "hood" display, mock striking, and feigning death.

KEY REFERENCES: Blem 1981, Edgren 1955, McCoy and Bianculli 1966, Smith 1956, Wright and Wright 1957.

Northern Ringneck Snake

(*Diadophis punctatus edwardsi*)



RANGE: Nova Scotia, s. Ontario to Wisconsin. Eastern and s. Ohio to se. Illinois, n. Alabama and ne. through c. Virginia to New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Secretive, found under cover especially in moist shady woodlands with abundant hiding cover: stony woodland pastures, rocks, stone walls, old woodland junk piles, logs, debris, loose bark of logs and stumps; shale banks in Maine (Fowler and Sutcliffe 1952), and boards are all used as cover. Hibernates from September to April or May. One individual found in a woodchuck den (Grizzel 1949).

SPECIAL HABITAT REQUIREMENTS: Mesic areas with abundant cover.

AGE/SIZE AT SEXUAL MATURITY: Males at 13 to 14 months (Fitch 1960b), males 220 to 500 mm, females 220 to 550 mm (Wright and Wright 1957:187).

BREEDING PERIOD: Soon after emerging from hibernation.

EGG DEPOSITION: Late June to early July. Eggs laid in rotted logs, under logs or stones. Several females may use the same nest.

CLUTCH SIZE: 1 to 10 eggs, typically 3 or 4 (Blanchard 1937b). Smaller females lay fewer eggs (Fitch 1970).

INCUBATION PERIOD: 4 to 6 weeks (Minton 1944). Average of 56 days in laboratory conditions (Blanchard 1937b, cited in Wright and Wright 1957:188).

EGGS HATCH: Late August through September.

HOME RANGE/MOVEMENT: Undocumented.

FOOD HABITS/PREFERENCES: Toads, frogs, salamanders, earthworms, lizards, small snakes, insects, and grubs.

COMMENTS: Nocturnal. Degree of fossorial tendency varies with temperature preference (Elick et al. 1979).

KEY REFERENCES: Schmidt and Davis 1941, Wright and Wright 1957.

Eastern Worm Snake

Carphophis a. amoenus)



RANGE: Southcentral Massachusetts, se. New York through c. Pennsylvania to s. Ohio. South to c. Alabama, Georgia and South Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally abundant.

HABITAT: Dry to moist forests, often near streams; in the loose soil of gardens or weedy pastures. Sandy areas favored (M. Klemens, personal communication). Found in dry oak/pitch pine areas in Springfield, Massachusetts, (J. Tyning, personal communication) and under loose bark slabs, logs, stones, leaves, and other debris. Fossorial; has extended periods of inactivity. Hibernates in rotting wood, underground, or in burrows of other animals. Remains underground until May except for warm sunny days.

SPECIAL HABITAT REQUIREMENTS: Loose soil for burrowing, cover objects.

AGE/SIZE AT SEXUAL MATURITY: 3 years (Fitch 1970).

FEEDING PERIOD: Probably spring to early summer (McCauley 1945:97) and fall (Fitch 1970).

EGG DEPOSITION: Late June to early July. Eggs probably laid in depressions under boulders or in hollow logs. Incubation period of 48 to 49 days in Kansas (Fitch 1970).

CLUTCH SIZE: 2 to 8 eggs (Wright and Wright 1957:106), typically 5 (McCauley 1945:55).

EGGS HATCH: August to September.

HOME RANGE/MOVEMENT: About 0.25 acre (0.1 ha) in Kentucky (Barbour 1971:240). Average for 10 individuals in a forested mountainous area of Kentucky was 253 m² or 0.025 ha (Barbour et al. 1969a).

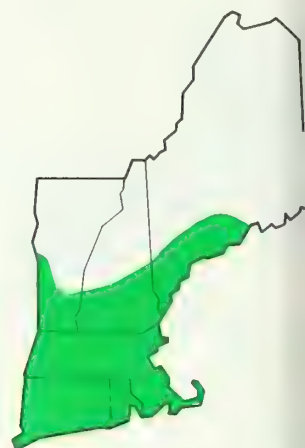
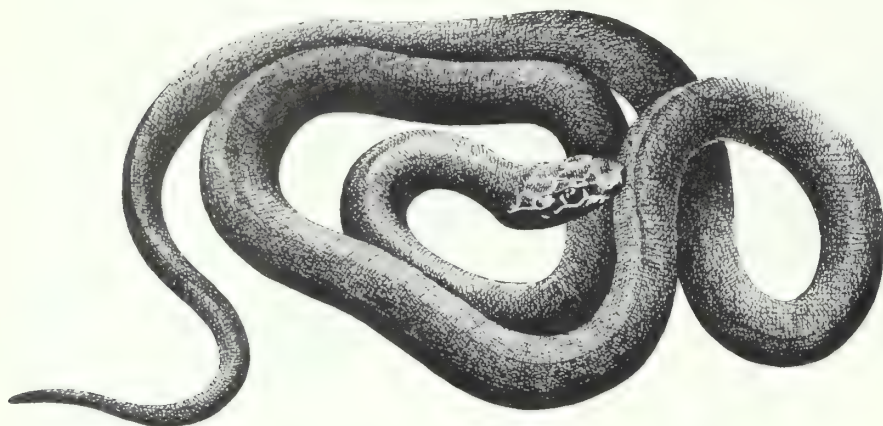
FOOD HABITS/PREFERENCES: Earthworms, soft-bodied insects and their larvae, grubs or slugs.

COMMENTS: Nocturnal and secretive.

KEY REFERENCES: Barbour et al. 1969a, Schmidt and Davis 1941, Wright and Wright 1957.

Northern Black Racer

(*Coluber c. constrictor*)



RANGE: Southern Maine to sw. Ohio, s. to c. Alabama to South Carolina and throughout the Eastern United States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally abundant.

HABITAT: Moist or dry areas, forests and wooded areas, fields, roadsides, swamps, marshes, clearings, near old buildings, trap rock ridges (M. Klemens, personal communication), stone walls, and farms. Has been found in deciduous and pine forests. Partially arboreal. Will use ledges for sunning.

Hibernates in large congregations, sometimes with copperheads and rattlesnakes, often using deep rock crevices or abandoned woodchuck holes. Among the earliest snakes to emerge from hibernation.

AGE/SIZE AT SEXUAL MATURITY: Males at 13 to 14 months (Fitch 1960b), males 680 to 1,595 mm, females 710 to 1,683 mm (Wright and Wright 1957:135).

BREEDING PERIOD: May to early June.

EGG DEPOSITION: June to early July. Laid in rotting wood, stumps, decaying vegetable matter, loose soil.

CLUTCH SIZE: 7 to 31 eggs, typically 16 to 17, clutch size proportional to size of female (Fitch 1963:420).

INCUBATION PERIOD: Average of 51 days (Fitch 1970).

EGGS HATCH: Late August to September.

HOME RANGE/MOVEMENT: Very territorial; seems to have definite home range (Smith 1956:239). Average distance of 903 feet (275.2 m) in mixed Maryland habitat for 3 individuals after 2 years (Stickel and Cope 1947). Requires large tracts of mixed old fields and woodlands (M. Klemens, personal communication).

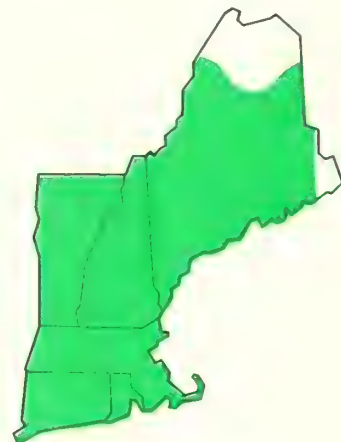
FOOD HABITS/PREFERENCES: Varied diet includes small mammals, insects, frogs, toads, small birds, birds' eggs, snakes and lizards (Uhler et al. 1939). Small mammals and insects are 50 percent of diet (Surface 1906).

COMMENTS: Diurnal.

KEY REFERENCES: Fitch 1963, Wilson 1978.

Eastern Smooth Green Snake

(*Opheodrys v. vernalis*)



RANGE: Nova Scotia, s. Ontario, into c. Minnesota to s. Wisconsin, Michigan, ne. Ohio to the Appalachians of Virginia and West Virginia and north from c. New Jersey throughout New England with the possible exception of Maine.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common, but currently declining in s. New England.

HABITAT: Upland areas, grassy fields, mountain meadow; high altitude areas with grassy, open spots. Also found in open aspen stands, sphagnum bogs, marshes, hedges and brambles, and hardwood stands.

SPECIAL HABITAT REQUIREMENTS: Upland grassy openings.

AGE/SIZE AT SEXUAL MATURITY: Probably second year (Seibert and Hagen 1947).

SPENDING PERIOD: Late August in Ontario (Smith 1966:236). Spring and late summer (Behler and King 1999:640).

EGG DEPOSITION: Late July to August.

CLUTCH SIZE: 3 to 12 eggs (Wright and Wright 1997:558), typically 7 (Blanchard 1933). Nest sites may be used by several females.

INCUBATION PERIOD: Varies from 4 to 23 days (Blanchard 1933).

EGGS HATCH: August to early September.

HOME RANGE/MOVEMENT: Less than 30 yards (27.4 m) for 10 of 12 individuals studied in an uncultivated field in Illinois (Seibert and Hagen 1947).

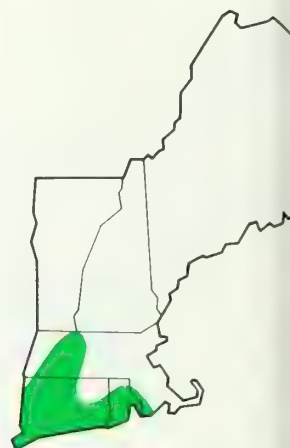
FOOD HABITS/PREFERENCES: Insects account for 73 percent of prey items, also spiders, snails (Surface 1906). Salamanders, millipedes, centipedes, particularly caterpillars, orthopterans, ants, flies (Uhler et al. 1939).

COMMENTS: Hibernates early fall to April or May. Population decline may be related to insecticide spraying and loss of open fields and pasture. Inhabits abandoned farmland dominated by successional vegetation and man-made debris on Long Island, New York (Schlauch 1975).

KEY REFERENCES: Schmidt and Davis 1941, Seibert and Hagen 1947, Wright and Wright 1957.

Black Rat Snake

(*Elaphe o. obsoleta*)



RANGE: Southwestern New England w. through s. New York to sc. Illinois, and the Mississippi River area in Wisconsin, south to Oklahoma, c. Louisiana and Georgia. Range may be extending n. in the Connecticut River Valley (T. Tynning, personal communication).

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Variety of habitats including woodlands, thickets, field edges, farmlands, rocky hillsides and mountaintops, river bottoms, old barns. Readily climbs trees. Found in dry oak and oak-hickory woods, and mesic bottomland forests, may occur in very dense woods (Wright and Wright 1957:232). In Connecticut found in gorges and some coastal areas (M. Klemens, personal communication).

Hibernates late November to April, may use talus slopes, cisterns or unused wells. Often found in groups with copperheads and rattlesnakes where these snakes occur.

AGE/SIZE AT SEXUAL MATURITY: At 4 years (Fitch 1970). Males 1,095 to 1,835 mm, females 715 to 1,800 mm (Wright and Wright 1957:233).

BREEDING PERIOD: May to June.

GESTATION PERIOD: 8 to 12 weeks (Oliver 1955:243).

EGG DEPOSITION: July to August. Laid in loose soil, decaying wood, manure piles, sawdust piles.

CLUTCH SIZE: 6 to 24 eggs, typically 14.

HOME RANGE/MOVEMENT: Average at least 600 m diameter for males, and at least 500 m for females in woods and fields in Maryland (Stickel et al. 1980).

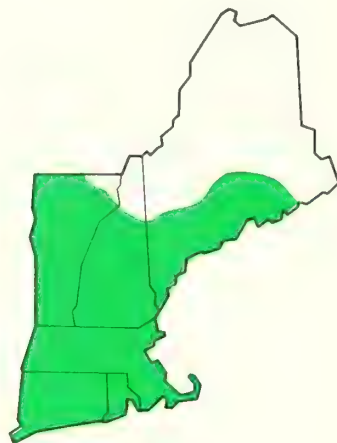
FOOD HABITS/PREFERENCES: Small mammals account 60 percent of prey items, particularly rodents, s. birds and their eggs (30 percent), also amphibians, insects, spiders (Uhler et al. 1939). Young opossums, v. sels, owls, and sparrow hawks have been captured as food (Minton 1972:272). Prey is killed by constriction.

COMMENTS: Formerly pilot or pilot black snake. Diurnal and arboreal. May reside in hollow trees (Cooper 1975:194).

KEY REFERENCES: Anderson 1965, Schmidt and Wright 1941, Smith 1956, Stickel et al. 1980, Wright and Wright 1957.

Eastern Milk Snake

(*Lampropeltis t. triangulum*)



RANGE: Southeastern Maine and s. Ontario to c. Minnesota, s. to Tennessee and w. North Carolina and throughout the Northeast. Intergrades with the scarlet king snake (*L. t. elapsoides*), in the sw. and se. portion of its range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Various habitats, usually with brushy or woody cover, and found from sea level to mountain elevations. Usually found under cover. Farmlands, woods, outbuildings, meadows, river bottoms, bogs, rocky hill-sides, rodent runways (M. Klemens, personal communication). Found under logs, stones, boards, well covers, stones in creek bottoms (M. Stewart, Personal communication) or other cover during the day. In pine forests, second-growth pine, bog woods, hardwoods, aspen lands. Hibernates from October or November to April.

SPECIAL HABITAT REQUIREMENTS: Suitable cover or loose soil for egg laying.

AGE/SIZE AT SEXUAL MATURITY: Third or fourth year (Fitch and Fleet 1970), males to 1,115 mm, females 404 to 866 mm (Wright and Wright 1957:371).

REEDING PERIOD: June (Wright and Wright 1957:371).

EGG DEPOSITION: Mid-June to July, in piles of soil, sawdust or manure, or under other cover, often in a communal nest site.

CLUTCH SIZE: 6 to 24 eggs, typically 13.

INCUBATION PERIOD: 6 to 8 weeks (Wright and Wright 1957:371).

EGGS HATCH: Late August to October.

HOME RANGE/MOVEMENT: About 50 acres (20.25 ha) for *L. t. sypila*, movements of 250 to 1,300 feet (76.2 to 396.2 m) in open woodland in ne. Kansas (Fitch and Fleet 1970). Seasonal movement probable from drier hibernation sites to moist bottomlands for the summer (Breckenridge 1958, cited in Williams 1978:79).

FOOD HABITS/PREFERENCES: Mice, other small mammals, other snakes, lizards, birds and their eggs, slugs. Mice accounted for 74 percent of the volume of stomach contents of 42 milk snakes in Pennsylvania (Surface 1908). Forages for food at night.

COMMENTS: Typically nocturnal. Numbers may be declining as abandoned fields revert to forests (T. Tynning, personal communication).

KEY REFERENCES: Fitch and Fleet 1970, Schmidt and Davis 1941, Wright and Wright 1957.

Northern Copperhead

(*Agkistrodon contortrix mokeson*)



RANGE: Southwestern New England to sw. Illinois, s. to c. Georgia and through c. North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Usually associated with deciduous forests. Occupies varied habitats from swamps to mountain tops. Prefers areas with damp leaf litter (Fitch 1960a:116). Exposed mountainous, rocky hillsides, talus slopes, basalt ridges, ledges, open woods. Found in habitats with large rocks, rotting wood, and sawdust piles. During summer months may be found near swamps, ponds, or streams. Largely outside of white pine-northern hardwood, and beech-maple associations (Fitch 1960a:123). Reinert (1984) found this species used relatively open areas with high rock density and low density surface vegetation.

SPECIAL HABITAT REQUIREMENTS: Rocky hillsides, talus slopes.

AGE/SIZE AT SEXUAL MATURITY: Males during their second summer, females at 3 years (Fitch 1960a:272).

BREEDING PERIOD: After emergence from hibernation in April to May, peak in late May. Sperm may remain viable in the female for more than a year after copulation (Allen 1955). Gestation period of 105 to 110 days (Fitch 1960a:116).

YOUNG BORN: August to September, typically September in the Northeast. Viviparous.

NO. OF YOUNG: 1 to 17 young, typically 5 to 6 (Wright and Wright 1957:913). Litters produced in alternate years.

HOME RANGE/MOVEMENT: In mixed habitat of wetlands, ledges and grassland in Kansas. Fitch (1960a:1149) recorded 24.4 acres (9.7 ha) for males and 8.5 acres (3.4 ha) for females. Seasonal movements occur between hibernaculum and lowland areas.

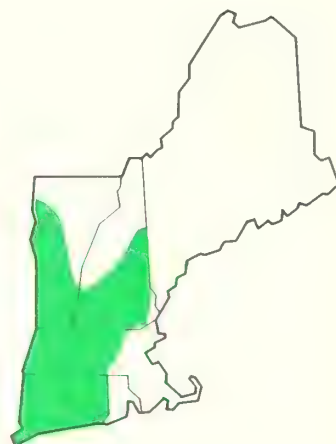
FOOD HABITS/PREFERENCES: Mice, other small rodents, insects, small birds, salamanders, lizards, small snakes, frogs, toads. Food obtained by ambush.

COMMENTS: Nocturnal during summer months, diurnal in spring and fall. Has survived eradication in some areas due to cryptic coloration and retiring habits. Usually gregarious. During hibernation (from October to April) sometimes found with other species of snakes including rattlesnakes, but mutually exclusive in Connecticut (Tattersen 1970). Den sites are reused each year — a major limiting factor.

KEY REFERENCES: Anderson 1965, Fitch 1960a, Reinert 1984, Schmidt and Davis 1941, Smith 1956, Wright and Wright 1957.

Timber Rattlesnake

Crotalus horridus)



RANGE: Southern New Hampshire, the Champlain Valley to sw. New York, w. along the Ohio River Valley and to the Mississippi River in Wisconsin. Extending to n. Texas s. Illinois, n. Georgia and through the Appalachians to New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Timbered areas with rocky outcroppings, dry ridges, and second growth deciduous or coniferous forests with high rodent populations. Usually southern exposures. Sometimes in swamps, quarries, old stone walls, abandoned buildings. Often found near streams in the summer. Most common in areas not frequented by man, few such sites remain. Reaches elevations of 6,000 feet (1,800 m) in the Southeast, but probably not found at highest elevations in the Northeast due to harsh climatic conditions (Klauber 1972:511). Reinert (1984) found that in Pennsylvania this species frequented forested habitats rather than dry, rocky outcroppings. Hibernates from September to April in large numbers in rocky crevices usually overgrown with brush. Found with copperheads and other snakes, due to paucity of hibernacula (T. Tynning, personal communication).

SPECIAL HABITAT REQUIREMENTS: Rock outcroppings on forested hillsides.

AGE/SIZE AT SEXUAL MATURITY: Probably 3-1/2 to 4 years (Klauber 1972:335).

BREEDING PERIOD: Fall in Connecticut (T. Tynning, personal communication) and Wisconsin (Messeling 1953). After emerging from hibernation (Fitch 1970). Gestation period probably about 5-1/2 to 6 months.

YOUNG BORN: Late August to September, probably biennial cycles (Klauber 1972:691). Viviparous.

NO. OF YOUNG: 5 to 17 young, typically 7 to 10 (Klauber 1972:733).

HOME RANGE/MOVEMENT: Females return to hibernation dens to give birth to young. Hibernation dens may be used year after year. Home ranges and favored refuges probably exist, but few investigations have been conducted (Klauber 1972:606-607).

FOOD HABITS/PREFERENCES: Prefers warm-blooded prey. Small mammals account for 87 percent of prey taken (Uhler et al. 1939), particularly mice, but includes rabbits, shrews, chipmunks, squirrels, bats, songbirds, and other snakes. Forages at night (Kimball 1978).

COMMENTS: Extirpated from much of its former range by man; overcollection and habitat disturbance are serious threats to *Crotalus horridus* in the Northeast. Danger to humans is grossly exaggerated.

KEY REFERENCES: Anderson 1965, Collins and Knight 1980, Klauber 1972, Wright and Wright 1957.

- Adler, K.K. Egg-laying in the spotted turtle, *Clemmys gutta* (Schneider). Ohio Journal of Science. 61: 180-182; 1961.
- Alexander, M.M. Food habits of the turtle in Connecticut. Journal of Wildlife Management. 7: 278-282; 1943.
- Allard, H.A. The natural history of the box turtle. Scientific Monthly. 41: 325-338; 1935.
- Allen, J.A. Catalogue of the reptiles and batrachians found in the vicinity of Springfield, Massachusetts, with notices of all the other species known to inhabit the state. Proceedings of the Boston Society of Natural History. 12: 171-204, 248-250; 1868.
- Allen, J.A. Notes on Massachusetts reptiles and batrachians. Proceedings of the Boston Society of Natural History. 13: 260-263; 1870.
- Allen W.B. Some notes on reptiles. Herpetologica. 11: 228; 1955.
- Anderson, J.D. *Ambystoma maculatum*. Catalogue of American Amphibians and Reptiles. 51.1-51.4; 1967a.
- Anderson, J.D. *Ambystoma opacum*. Catalogue of American Amphibians and Reptiles. 46.1-46.2; 1967b.
- Anderson, J.D. Embryonic temperature tolerance and rate of development in some salamanders of the genus *Ambystoma*. Herpetologica. 28(2): 126-130; 1972.
- Anderson J.D.; Giacosis, R.V. *Ambystoma laterale* in New Jersey. Herpetologica. 23: 108-111; 1967.
- Anderson, J.D.; Williamson, G.K. The breeding season of *Ambystoma opacum* in the northern and southern parts of its range. Journal of Herpetology. 7(3): 320-321; 1973.
- Anderson, P. The reptiles of Missouri. Columbia, MO; University of Missouri Press; 1965. 330 p.
- Ashton, R.E., Jr. A study of movement, home range, and winter behavior of *Desmognathus fuscus* (Rafinesque). Journal of Herpetology. 9: 85-91; 1975.
- Ashton, R.E., Jr. Endangered and threatened amphibians and reptiles in the United States. Milwaukee, WI: Society for the Study of Amphibians and Reptiles; 1976; Herpetol. Circ. 5.
- Ashton, R.E.; Ashton, P.S. Movements and winter behavior of *Eurycea bislineata* (Amphibia, Urodela, Plethodontidae). Journal of Herpetology. 12: 295-298; 1978.
- Austin, N.E.; Bogart, J.P. Erythrocyte area and ploidy determination in the salamanders of the *Ambystoma jeffersonianum* complex. Copeia. (2): 485-488; 1982.
- Babbitt, L.H. The *Amphibia* of Connecticut. Hartford, CT: Connecticut Geological and Natural History Survey Bulletin. 57: 9-50; 1937.
- Babcock, H.L. The turtles of New England. Memoirs of the Boston Society of Natural History. 8: 325-431; 1919.
- Bailey, R.M. Temperature tolerance of garter snakes in hibernation. Ecology. 30: 238-242; 1949.
- Ball, S.C. The distribution and behavior of the spadefoot toad in Connecticut. Transactions Connecticut Academy of Arts and Science. 32: 351-379; 1936.
- Banasiak, C.F. Population structure and reproductive ecology of the red-backed salamander in DDT-treated forests of northern Maine. Orono, ME: University of Maine; 1974. Ph.D. dissertation.
- Barbour, R.W. Amphibians and reptiles of Kentucky. Lexington, KY: University Press of Kentucky; 1971.
- Barbour, R.W.; Harvey, M.J.; Hardin, J.W. Home range, movement, and activity of the eastern wood snake, *Carhophis a. amoenus*. Ecology. 50: 470-479; 1969a.
- Barbour, R.W.; Hardin, J.W.; Schafer, J.P.; Harvey, M.J. Home range, movement, and activity of the dusky salamander, *Desmognathus fuscus*. Copeia. 1969: 293-297; 1969b.
- Barrett, J.W. Regional silviculture of the United States. New York, NY: Ronald Press; 1962.
- Bartholmus, G.T.; Bellis, E.D. Homing in the northern dusky salamander, *Desmognathus f. fuscus* (Rafinesque). Copeia. 1969: 148-153; 1969.
- Barton, A.J. Our knowledge of the bog turtle, *Clemmys muhlenbergi*, further augmented. Pittsburgh, PA: University of Pittsburgh; 1957. M.S. thesis.
- Barton, A.J.; Price, J.W. Our knowledge of the bog turtle, *Clemmys muhlenbergi*, surveyed and further augmented. Copeia. 1955: 159-165; 1955.
- Behler, John L.; King, F. Wayne. The Audubon Society field guide to North American reptiles and amphibians. New York, NY: Alfred A. Knopf, Inc.; 1979. 422 p.
- Bellis, E.D. Growth of the wood frog, *Rana sylvatica*. Copeia. 1961: 74-77; 1961.
- Bellis, E.D. Home range and movements of the wood frog in a northern bog. Ecology. 46: 90-98; 1965.
- Bellis, E.D. Summer movement of red-spotted newts in a small pond. Journal of Herpetology. 1: 86-91; 1968.
- Bishop, S.C. The salamanders of New York. New York: State Museum Bulletin. 324: 1-365; 1941.
- Bishop, S.C. Handbook of salamanders. The salamanders of the United States, of Canada, and Lower California. Ithaca, NY: Comstock; 1947.
- Blanchard, F.N. The life history of the four-toed salamander. American Naturalist. 57: 262-268; 1923.
- Blanchard, F.N. Further studies on the eggs and young of the eastern ringneck snake, *Diadophis punctatus edwardsii*. Bulletin Antivenin Institute of America. 4-10; 1930.
- Blanchard, F.N. Eggs and young of the smooth green snake, *Liopeltis vernalis* (Harlan). Paper of the Michigan Academy of Science, Arts and Letters. 17: 450-458; 1933a.
- Blanchard, F.N. Late autumn collections and hibernating situations of the salamander, *Hemicacetylum striatum* (Schlegel), in southern Michigan. Copeia. 1933: 216-217; 1933b.
- Blanchard, F.N. The relation of the four-toed salamander to her nest. Copeia. 1934: 136-137; 1934.
- Blanchard, F.N. Data on the natural history of the redbellied snake, *Storeria occipito-maculata* (Storer) in northern Michigan. Copeia. 1937: 151-162; 1937a.

- Blanchard, F.N. Eggs and natural nests of the eastern ring-neck snake, *Diadophis punctatus edwardsii*. Paper of the Michigan Academy of Science, Arts and Letters. 22: 521-532; 1937b.
- Blanchard, F.N.; Blanchard, F.C. Mating of the garter snake, *Thamnophis s. sirtalis* (Linnaeus). Paper of the Michigan Academy of Science, Arts and Letters. 27: 215-234; 1942.
- Brinkley, J.S. The amphibians and reptiles of Nova Scotia. Canadian Field-Naturalist. 66: 125-129; 1952.
- Brinkley, J.S. The egg-laying habits of the salamander, *Ambystoma jeffersonianum*. Copeia. 1957: 141-142; 1957.
- Brinkley, J.S. A zoogeographical study of the amphibians and reptiles of eastern Canada. Natural Museum of Canada Bulletin. 155, Biol series 54; 1958.
- Brinkley, J.S. *Thamnophis s. sirtalis* (Linnaeus) in eastern Canada, redescription of *T. s. pallidula* (Allen). Copeia. 1959: 52-56; 1959.
- Burns, C.R. *Heterodon platyrhinos* Latreille. Catalogue of American Amphibians and Reptiles. 282.1-282.2; 1981.
- Cagle, A.N. Gnomes of the night, the spadefoot toads. Philadelphia, PA: University Pennsylvania Press; 1956.
- Crandall, R.A. A comparison of the larvae of five north-eastern species of *Ambystoma* (Amphibia, Caudata). Copeia. 1961: 377-383; 1961.
- Crandall, R.A. *Gyrinophilus porphyriticus* (Green). Catalogue of American Amphibians and Reptiles. 33.1-33.3; 1967.
- Creech, W.J. Reptiles and amphibians of Minnesota. 2d ed. Minneapolis, MN: University Minnesota Press; 1958.
- Crocker, R.B. Turtle trailing: A new technique for studying the life habits of certain testudinata. Zoologica. 9: 231-243; 1927.
- Croder, E.D. Investigations on the skin toxin of the red-spotted newt, *Notophthalmus v. viridescens*. American Midland Naturalist. 80: 276-280; 1968.
- Croder, E.D.; Formanowicz, D.R., Jr. Palatability and antipredator behavior of the treefrog *Hyla versicolor* to the shrew, *Blarina brevicauda*. Journal of Herpetology. 15(2): 235-236; 1981.
- Crown, E.E. Stray food records from New York and Michigan snakes. American Midland Naturalist. 102: 200-203; 1979.
- Cruce, R.C. Fecundity in primitive plethodontid salamanders. Evolution. 23: 50-54; 1969.
- Cruce, R.C. Variation in the life cycle of the salamander, *Gyrinophilus porphyriticus*. Herpetologica. 28: 230-245; 1972.
- Cruce, R.C. A model of the larval period of the spring salamander, *Gyrinophilus porphyriticus*, based on size-frequency distributions. Herpetologica. 36: 78-86; 1980.
- Curger, J.W. *Plethodon cinereus* (Green) in eastern Pennsylvania and New Jersey. American Naturalist. 69: 578-586; 1935.
- Burton, T.M. An analysis of the feeding ecology of the salamanders (Amphibia, Urodela) of the Hubbard Brook Experimental Forest, New Hampshire. Journal of Herpetology. 10: 187-204; 1976.
- Burton, T.M. Population estimates, feeding habits and nutrient and energy relationships of *Notophthalmus v. viridescens*, Mirror Lake, New Hampshire. Copeia. 1977: 139-143; 1977.
- Burton, T.M. Likens, G.E. Salamander populations and biomass in Hubbard Brook Experimental Forest, New Hampshire. Copeia. 1975: 541-546; 1975.
- Bury, R.B. Review of the ecology and conservation of the bog turtle, *Clemmys muhlengeri*. Washington, DC: U.S. Fish and Wildlife Service, Special Scientific Report; 1979; Wildl. No. 219. 9p.
- Cagle, F.R. Herpetological fauna of Jackson and Union Counties, Illinois. American Midland Naturalist. 28: 164-200; 1942.
- Cagle, F.R. Home range, homing behavior, and migration in turtles. Ann Arbor, MI: University of Michigan, Miscellaneous Publications of the Museum of Zoology. 61: 1-34; 1944.
- Cagle, F.R. The life history of the slider turtle, *Pseudemys scripta troostii* (Holbrook). Ecological Monographs. 20: 31-54; 1950.
- Cahn, A.R. The turtles of Illinois. Illinois Biological Monographs. 16: 1-218; 1937.
- Caldwell, R.S. Observations on the winter activity of the red-backed salamander, *Plethodon cinereus*, in Indiana. Herpetologica. 31: 21-22; 1975.
- Carpenter, C.C. Growth and maturity of three species of *Thamnophis* in Michigan. Copeia. 1952: 237-243; 1952a.
- Carpenter, C.C. Comparative ecology of the common garter snake (*Thamnophis s. sirtalis*), the ribbon snake (*Thamnophis s. sauritus*), and Butler's garter snake (*Thamnophis butleri*) in mixed populations. Ecological Monographs. 22: 236-258; 1952b.
- Carr, A.F. Handbook of turtles of the United States, Canada, and Baja, California. Ithaca, NY: Comstock; 1952.
- Center for Natural Areas. Reptiles and amphibians. In: A preliminary listing of noteworthy and natural features in Maine. Augusta, ME: State Planning Office; 1976: 260-265.
- Clarke, R.D. Activity and movement patterns in a population of Fowler's toad, *Bufo woodhousii fowleri*. American Midland Naturalist. 92: 257-274; 1974.
- Clausen, H.J. Observations on the brown snake *Storeria dekayi* (Holbrook), with special reference to the habits and birth of young. Copeia. 1936(2): 98-102; 1936.
- Collins, J.T.; Conant, R.; Huheey, J.E.; Knight, J.L.; Rundquist, E.M.; Smith, H.M. Standard common and current scientific names for North American amphibians and reptiles. 2d ed. Milwaukee, WI: Society for the Study of Amphibians and Reptiles; 1982; Herpetol. Circ. 12. 28 p.

- Collins, J.T.; Knight, J.L. *Crotalus horridus*. Linnaeus. Catalogue of American Amphibians and Reptiles. 253.1-253.2; 1980.
- Conant, R. The reptiles of Ohio. American Midland Naturalist. 20(1): 1-200; 1938.
- Conant, R. Reptiles and amphibians of the Northeastern states. 3d ed. Philadelphia, PA: Zoological Society of Philadelphia; 1957.
- Conant, R. A field guide to reptiles and amphibians of eastern and central North America. 2d ed. Boston, MA: Houghton Mifflin Co.; 1975.
- Cooper, J.E. Aquatic hibernation of the red-backed salamander. Herpetologica. 12: 165-166; 1956.
- Cooper, J.E. The turtle *Pseudemys scripta* feral in Maryland. Herpetologica. 15: 44; 1985.
- Craig, R.J. The rare vertebrates of Connecticut. Storrs, CT: USDA Soil Conservation Service; 1979.
- Currie, W.; Bellis, E.D. Home range and movements of the bullfrog, *Rana catesbeiana* (Shaw), in an Ontario Pond. Copeia. 1969: 688-692; 1969.
- Danstedt, R.T., Jr. Local geographic variation in demographic parameters and body size of *Desmognathus fuscus* (Amphibia, Plethodontidae). Ecology. 56:1054-1067; 1975.
- Davidson, J.A. Notes on the food habits of the slimy salamander, *Plethodon g. glutinosus*. Herpetologica. 12: 129-131; 1956.
- Delzell, D.E. Spatial movement and growth of *Hyla crucifer*. Ann Arbor, MI: University of Michigan; 1958. Ph.D. dissertation.
- Dickerson, M.C. The frog book. New York, NY: Dover Publ., Inc.; 1969.
- Dole, J.W. Summer movements of adult leopard frogs, *Rana pipiens* (Schreber), in northern Michigan. Ecology. 46: 236-255; 1965.
- Dole, J.W. Homing in leopard frogs, *Rana pipiens*. Ecology. 49: 386-399; 1968.
- Dole, J.W. Celestial orientation in recently metamorphosed *Bufo americanus*. Herpetologica. 29(1): 59-62; 1973.
- Douglas, M.E.; Monroe, B.L. A comparative study of topographical orientation in *Ambystoma* (Amphibia: Caudata). Copeia. 1981: 460-463; 1981.
- Drake, C.J. The food of *Rana pipiens* (Schreber). Ohio Naturalist. 14: 257-269; 1914.
- Driver, E.C. Observations on *Scaphiopus holbrooki* (Harlan). Copeia. 1936: 67-69; 1936.
- Dunn, E.R. The salamanders of the family Plethodontidae. Northampton, MA: Smith College; 1926.
- Edgren, R.A. The natural history of the hog-nosed snakes, genus *Heterodon*: A review. Herpetologica. 11: 105-117; 1955.
- Edgren, R.A. Ovulation time in the musk turtle, *Sternotherus oedeatus* (Latreille). Natural History Miscellanea. 152: 1-3; 1960.
- Elick, G.E.; Sealander, J.A.; Beumer, R.J. Temperature preference, body temperature tolerances, and habitat selection of small Colubrid snakes. Transactions of the Missouri Academy of Science. 13: 21-31; 1979.
- Emlen, S.T. Territoriality in the bullfrog, *Rana catesbeiana*. Copeia. 1968: 240-243; 1968.
- Ernst, C.H. A Homing ability in the spotted turtle, *Clemmys guttata* (Schneider). Herpetologica. 24: 77-78 1968a.
- Ernst, C.H. A turtle's territory. International Turtle and Tortoise Society Journal. 2(6): 9, 34; 1968b.
- Ernst, C.H. Home range of the spotted turtle. Copeia 1970: 391-392; 1970.
- Ernst, C.H. *Chrysemys picta* (Schneider). Catalogue of American Amphibians and Reptiles. 106.1-106.4 1971.
- Ernst, C.H. *Clemmys guttata* (Schneider). Catalogue of American Amphibians and Reptiles. 124.1-124.2 1972a.
- Ernst, C.H. *Clemmys insculpta* (LeConte). Catalogue of American Amphibians and Reptiles. 125.1-125.2 1972b.
- Ernst, C.H. Biological notes on the bog turtle, *Clemmys muhlenbergii*. Herpetologica. 33: 241-246; 1977.
- Ernst, C.H. Barbour, R.W. Turtles of the United States. Lexington, KY: University Press of Kentucky; 1972.
- Ernst, C.H. Bury, R.B. *Clemmys muhlenbergii* (Schoepff). Catalogue of American Amphibians and Reptiles. 204.1-204.2; 1977.
- Evermann, B.W.; Clarke, H.W. The turtles and batrachians of the Lake Maxin Kuekee region. Proceedings of the Indiana Academy of Science. 1916: 472-518 1916.
- Ewing, H.E. Continued fertility in the female box turtle following mating. Copeia. 1943: 112-114; 1943.
- Finneran, L.C. Reptiles in Branford, Connecticut. Herpetologica. 4: 123-126; 1948.
- Fitch, H.S. Life history and ecology of the five-lined skink, *Eumeces fasciatus*. University of Kansas Publication of the Museum of Natural History. 8: 1-156 1954.
- Fitch, H.S. Autecology of the copperhead. University of Kansas Publication of the Museum of Natural History 13: 185-288; 1960a.
- Fitch, H.S. Criteria for determining sex and breeding maturity in snakes. Herpetologica. 16: 49-51; 1960b.
- Fitch, H.S. Natural history of the racer *Coluber constrictor*. University of Kansas Publication of the Museum of Natural History. 15: 351-468; 1963.
- Fitch, H.S. An ecological study of the garter snake *Thamnophis sirtalis*. University of Kansas Publication of the Museum of Natural History. 15: 493-564; 1965.
- Fitch, H.S. Reproductive cycles of lizards and snakes. University of Kansas Museum of Natural History Miscellaneous Publication. 52; 1970.
- Fitch, H.S. *Thamnophis sirtalis* (Linnaeus). Catalogue of American Amphibians and Reptiles. 270.1-270.4 1980.
- Fitch, H.S.; Fleet, R.R. Natural history of the milk snake (*Lampropeltis triangulum*) in northeastern Kansas. Herpetologica. 26: 387-396; 1970.
- Fitzpatrick, L.C. Energy allocation in the Allegheny Mountain salamander, *Desmognathus ochrophaeus*. Ecological Monographs. 43: 43-58; 1973.

- orce, E.R. The age of attainment of sexual maturity of the Leopard frog, *Rana pipiens* (Schreber), in northern Michigan. *Copeia*. 1933: 128-131; 1933.
- prester, D.C. Comments on the female reproductive cycle and philopatry by *Desmognathus ochrophaeus* (Amphibia, Urodela, Plethodontidae). *Journal of Herpetology*. 11: 311-316; 1977.
- prester, D.C. Homing to the nest by female mountain dusky salamander, *Desmognathus ochrophaeus*, with comments on the sensory modalities essential to clutch recognition. *Herpetologica*. 35: 330-335; 1979.
- owler, J.A.; Sutcliffe, R. An additional record for the purple salamander, *Gyrinophilus p. porphyriticus*, from Maine. *Copeia*. 1952: 48-49; 1952.
- aker, M.A. Home range and homing in the watersnake, *Natrix s. sipedon*. *Copeia*. 1970: 665-673; 1970.
- ans, C. Occurrence of the dusky salamander on Manhattan. *Copeia*. 1945(2): 118; 1945.
- atz, A.J., Jr. Critical thermal maxima of *Ambystoma maculatum* and *A. jeffersonianum* in relation to time of breeding. *Herpetologica*. 27: 157-160; 1971.
- ibbons, J.W. Reproductive potential, activity and cycles in the painted turtle, *Chrysemys picta*. *Ecology*. 49: 399-409; 1968a.
- ibbons, J.W. Observations on the ecology and population dynamics of the Blanding's turtle, *Emydoidea blandingii*. *Canadian Journal of Zoology*. 4: 288-290; 1968b.
- ochfeld, M. The decline of the eastern garter snake, *Thamnophis s. sirtalis*, in a rural residential section of Westchester County, New York. *Engelhardtia*. 6: 23-24; 1975.
- ordon, D.M. An investigation of the ecology of the map turtle, *Graptemys geographica* (LeSueur), in the northern part of its range. *Canadian Journal of Zoology*. 58: 2210-2230; 1980.
- ordon, R.E. Terrestrial activity of the spotted salamander, *Ambystoma maculatum*. *Copeia*. 1968: 879-880; 1968.
- osner, K.; Black, J.H. The effects of temperature and moisture on the reproductive cycle of *Scaphiopus h. holbrooki*. *American Midland Naturalist*. 54: 192-203; 1955.
- Graham, T.E. Growth rate of the red-bellied turtle, *Chrysemys rubriventris*, at Plymouth, Massachusetts. *Copeia*. 1971: 353-356; 1971a.
- Graham, T.E. Eggs and hatchlings of the red-bellied turtle, *Chrysemys rubriventris*, from Plymouth, Massachusetts. *Journal of Herpetology*. 5: 59-60; 1971b.
- Graham, T.E. Red-belly blues. *Animals*. 113: 17-21; 1980.
- Graham, T.E. Second find of *Pseudemys rubriventris* at Ipswich, Massachusetts, and refutation of the Naushon Island record. *Herpetological Review*. 13(3): 82-83; 1982.
- Graham, T.E.; Doyle, T.S. Growth and population characteristics of Blanding's turtle, *Emydoidea blandingii*, in Massachusetts. *Herpetologica*. 33: 410-414; 1977.
- Graham, T.E.; Doyle, T.S. Dimorphism, courtship, eggs, and hatchlings of the Blanding's turtle, *Emydoidea blandingii* (Reptilia, Testudines, Emydidae), in Massachusetts. *Journal of Herpetology*. 13: 125-127; 1979.
- Graham, T.E.; Hutchinson, V.H. Centenarian box turtles. *International Turtle and Tortoise Society Journal*. 3: 24-29; 1969.
- Graham, T.E.; Hutchinson, V.H. Effect of temperature and photoperiod acclimatization on thermal preferences of selected freshwater turtles. *Copeia*. 1979: 165-169; 1979.
- Grant, W.C. Territorialism in two species of salamanders. *Science*. 121: 137-138; 1955.
- Grizzell, R.A., Jr. The hibernation site of three snakes and a salamander. *Copeia*. 1949: 231-132; 1949.
- Groves, J.D. Egg-eating behaviour of brooding five-lined skinks, *Eumeces fasciatus*. *Copeia*. 1982(4): 969-971; 1982.
- Hairston, N.H. The local distribution and ecology of the plethodontid salamanders of the southern Appalachians. *Ecological Monographs*. 19: 47-73; 1949.
- Hamilton, W.J., Jr. The food and feeding habits of some eastern salamanders. *Copeia*. 1932: 83-86; 1932.
- Hamilton, W.J., Jr. The rate of growth of the toad *Bufo a. americanus* (Holbrook) under natural conditions. *Copeia*. 1934: 88-90; 1934.
- Hamilton, W.T., Jr. The food and feeding behavior of the green frog, *Rana clamitans* (Latreille), in New York State. *Copeia*. 1948: 203-207; 1948.
- Hamilton, W.J., Jr. The food and feeding behavior of the garter snake in New York. *American Midland Naturalist*. 46: 385-390; 1951.
- Hamilton, W.J. Jr. The economic status of the toad. *Herpetologica*. 10: 37-40; 1954.
- Hammer, D.A. Parameters of a marsh snapping turtle population, Lacreek Refuge, South Dakota. *Journal of Wildlife Management*. 33: 995-1005; 1969.
- Harding, J.H. Record egg clutches for *Clemmys insculpta*. *Herpetological Review*. 8(2): 34; 1977.
- Harding, J.H.; Bloomer, T.J. The wood turtle, *Clemmys insculpta*. . . a natural history. *HERP Bull. of the New York Herpetological Society* 15(1): 9-26; 1979.
- Harris, R.N. Intrapond homing behavior in *Notophthalmus viridescens*. *Journal of Herpetology*. 15(3): 355-356; 1981.
- Hassinger, D.D.; Anderson, J.D.; Dalrymple, G.H. The early life history and ecology of *Ambystoma tigrinum* and *Ambystoma opacum* in New Jersey. *American Midland Naturalist*. 84: 474-495; 1970.
- Healy, W.R. Population consequences of alternative life histories in *Notophthalmus v. viridescens*. *Copeia*. 1974: 221-229; 1974.
- Heatwole, H. Habitat selection and activity of the wood frog, *Rana sylvatica* (LeConte). *American Midland Naturalist*. 66: 301-313; 1961.
- Heatwole, H. Environmental factors influencing local distribution and activity of the salamander, *Plethodon cinereus*. *Ecology*. 43: 460-472; 1962.

- Hedeen, S.E. The ecology and life history of the mink frog, *Rana septentrionalis* (Braid). Minneapolis, MN: University of Minnesota; 1970. Ph.D. dissertation.
- Hedeen, S.E. Postmetamorphic growth and reproduction of the mink frog, *Rana septentrionalis* (Braid) Copeia. 1972(1): 169-175; 1972.
- Hedeen, S.E. *Tana septentrionalis* (Braid). Catalogue of American Amphibians and Reptiles. 202.1-202.2; 1977.
- Herreid, C.F.; Kinney, S. Temperature and development of the wood frog, *Rana sylvatica*, in Alaska. Ecology. 48: 579-589; 1967.
- Highton, R. The life history of the slimy salamander, *Plethodon glutinosus*, in Florida. Copeia. 1956: 75-93; 1956.
- Highton, R. Geographic variation in the life history of the slimy salamander. Copeia. 1962: 597-613; 1962.
- Hoff, J.G. A Massachusetts hibernation site of the red-backed salamander, *Plethodon cinereus*. Herpetological Review. 8: 33; 1977.
- Huheey, J.E.; Brandon, R.A. Rock-face populations of the mountain salamander, *Desmognathus ochrophaeus*, in North Carolina. Ecological Monographs. 43: 59-77; 1973.
- Hurlbert, .H. The breeding migrations and interhabitat wandering of the vermilion-spotted newt, *Notophthalmus viridescens* (Rafinesque). Ecological Monographs. 39: 465-488; 1969.
- Hurlbert, S.H. The post-larval migration of the red-spotted newt, *Notophthalmus viridescens* (Rafinesque). Copeia. 1970: 515-528; 1970.
- Husting, E.L. Survival and breeding structure in a population of *Ambystoma maculatum*. Copeia. 1965: 352-362; 1965.
- Ingram, W.M.; Raney, E.C. Additional studies on the movement of tagged bullfrogs, *Rana catesbeiana* (Shaw). American Midland Naturalist. 29: 239-241; 1943.
- Jameson, E.W., Jr. Food of the red-backed salamander. Copeia. 1944: 145-147; 1944.
- Johnson, J.E.; Goldberg, A.S. Movement of larval two-lined salamanders (*Eurycea bislineata*) in the Mill River, Massachusetts. Copeia. 1975: 588-589; 1975.
- Karns, D.R. Ecological risks for amphibians at toxic bog water breeding sites in northern Minnesota. In: Proceedings 1980 Joint Annual Herpetologists League/Society for the Study of Amphibians and Reptiles, Milwaukee, WI. Abstract.
- Keen, W.H. Feeding and activity patterns in the salamander *Desmognathus ochrophaeus* (Amphibia, Urodela, Plethodontidae). Journal of Herpetology. 13: 461-467; 1979.
- Keen, W.H.; Orr, L.P. Reproductive cycle, growth and maturation of northern female *Desmognathus ochrophaeus*. Journal of Herpetology. 14: 7-10; 1980.
- Kimball, D., ed. The timber rattlesnake in New England. A symposium; 1977 September 17; Springfield, MA. Springfield, MA: Western Massachusetts Herpetological Society; 1978.
- Kiviat, E. A Hudson River tide-marsh snapping turtle population. Transactions of the Northeast Fish and Wildlife Conference. 37: 158-168; 1980.
- Klauber, L.M. Rattlesnakes. 2 Vols. Berkeley and Los Angeles, CA: University of California Press; 1972.
- Kleeberger, S.R.; Werner, J.K. Home range and homing behavior of *Plethodon cinereus* in northern Michigan. Copeia. 1982: 409-415; 1982.
- Kramek, W.C. Food of the frog *Rana septentrionalis* in New York. Copeia. 1972: 390-392; 1972.
- Kramek, W.C. Feeding behavior of *Rana septentrionalis* (Amphibia, Anura, Ranidae). Journal of Herpetology. 10: 251-252; 1976.
- Krysiak, A.J. Microhabitat selection and brooding phenology of *Desmognathus f. fuscus* in western Pennsylvania. Journal of Herpetology. 14: 291-292; 1980.
- Lagler, K.F. Food habits and economic relations of the turtles of Michigan with special reference to game management. American Midland Naturalist. 29: 257-312; 1943.
- Lamson, G.H. The reptiles of Connecticut. Connecticut Geological and Natural History Survey Bulletin. 54; 1935.
- Landre, E. The blue-spotted salamander. Sanctuary Bulletin Massachusetts Audubon Society. 20: 6-7; 1980.
- Lazell, J.D., Jr. Blue-spotted salamander. Massachusetts Audubon Society Bulletin. 53(2): 20-25; 1968.
- Lazell, J.D., Jr. Reptiles and amphibians in Massachusetts. Lincoln, MA: Audubon Society; 1972.
- Lazell, J.D., Jr. This broken archipelago. New York, NY: Demeter Press, Quadrangle, New York Times Book Co.; 1976.
- Lazell, J.D., Jr. Teetering toward oblivion. Massachusetts Wildlife. 30(4): 15-18; 1979.
- Linzey, D.W. Food of the leopard frog, *Rana p. pioiens*, in central New York. Herpetologica. 23: 11-17; 1967.
- Logier, E.B.S. The frogs, toads and salamanders of eastern Canada. Toronto, ON: University of Toronto Press; 1952.
- Lotter, F. Reproductive ecology of the salamander, *Plethodon cinereus* (Amphibia, Urodela, Plethodontidae) in Connecticut. Journal of Herpetology. 12: 231-236; 1978.
- Lucas, F.A. Occurrence of *Pseudemys* at Plymouth, Mass. Copeia. 38: 98-100; 1916.
- Lynn, W.G.; vonBrand, T. Studies on the oxygen consumption and water metabolism of turtle embryos. Biological Bulletin. 88: 112-125; 1945.
- McCauley, R.H., Jr. The reptiles of Maryland and District of Columbia. Hagerstown, MD: Published by author; 1945.
- McCoy, C.J.; *Emydoidea blandingii*. Catalogue of American Amphibians and Reptiles. 136.1-136.4; 1973.
- McCoy, C.J.; Bianculli, A.V. The distribution and dispersal of *Heterodon platyrhinos* in Pennsylvania. Journal of Ohio Herpetological Society. 5: 153-158; 1966.

- MacNamara, M.C. Food habits of terrestrial adult migrants and immature red eft of the red-spotted newt, *Notophthalmus viridescens*. *Herpetologica*. 33: 127-132; 1977.
- Mahmoud, I.Y. Feeding behavior in Kinosternid turtles. *Herpetologica*. 24: 300-305; 1968.
- Mahmoud, I.Y. Comparative ecology of the Kinosternid turtles of Oklahoma. *Southwest Naturalist*. 14: 31-66; 1969.
- Marshall, W.H.; Buell, M.F. A study of the occurrence of amphibians in relation to a bog succession, Itasca State Park, Minnesota. *Ecology*. 36: 381-387; 1955.
- Martof, B.S. Territoriality in the green frog, *Rana clamitans*. *Ecology*. 34: 165-174; 1953a.
- Martof, B.S. Home range and movements of the green frog, *Rana clamitans*. *Ecology*. 34: 529-543; 1953b.
- Martof, B.S. Factors influencing size and composition of populations of *Rana clamitans*. *American Midland Naturalist*. 56: 224-245; 1956.
- Martof, B.S. *Rana sylvatica* (LeConte). *Catalogue of American Amphibians and Reptiles*. 86.1-86.4; 1970.
- Martof, B.S.; Palmer, W.M.; Bailey, J.R.; Harrison, J.R. III. *Amphibians and reptiles of the Carolinas and Virginia*. Chapel Hill, NC: University of North Carolina Press; 1980.
- Massachusetts Division of Fisheries and Wildlife. Species for special consideration in Massachusetts. Publ. 11094-5-100-12-78-CR. Westboro, MA: Massachusetts Division of Fisheries and Wildlife; 1978.
- Maynard, E.A. The aquatic migration of the toad, *Bufo americanus* (LeConte). *Copeia*. 1934: 174-177; 1934.
- Mecham, J.S. *Notophthalmus viridescens*. *Catalogue of American Amphibians and Reptiles*. 53.1-53.4; 1967.
- Messeling, E. Rattlesnakes in southwestern Wisconsin. *Conservation Bulletin*. 18(10): 21-23; 1953.
- Minton, S.A., Jr. Introduction to the study of the reptiles of Indiana. *American Midland Naturalist*. 32: 438-477; 1944.
- Minton, S.A., Jr. Salamanders of the *Ambystoma jeffersonianum* complex in Indiana. *Herpetologica*. 10: 173-179; 1954.
- Minton, S.A., Jr. *Amphibians and reptiles of Indiana*. Indiana. Indianapolis, IN: Indiana Academy of Science; 1972.
- Mittleman, M.B. *Eurycea bislineata* (Green). *Catalogue of American Amphibians and Reptiles*. 45.1-45.4; 1966.
- Moore, J.A. Temperature tolerance and rates of development in eggs of amphibia. *Ecology*. 20: 459-478; 1939.
- Moore, J.E.; Strickland, E.H. Further notes on the food of Alberta amphibians. *American Midland Naturalist*. 54: 253-256; 1955.
- Morgan, A.H.; Grierson, M.C. Winter habits and yearly food consumption of adult spotted newts, *Triturus viridescens*. *Ecology*. 13: 54-62; 1932.
- Neill, W.T. *Hemidactylium scutatum*. *Catalogue of American Amphibians and Reptiles*. 2.1-2.2; 1963.
- Nemuras, K. Survival of the Muhlenberg. *International Turtle and Tortoise Society Journal*. 3(5): 18-21; 1969.
- Newman, H.H. The habits of certain tortoises. *Journal of Comparative Neurology and Psychology*. 16: 126-152; 1906.
- Nichols, J.T. Range and homing of individual box turtles. *Copeia*. 1939: 125-127; 1939.
- Moble, G.K.; Brady, M.K. Observations on the life history of the marbled salamander, *Ambystoma opacum* (Gravenhorst). *Zoologica*. 11: 89-132; 1933.
- Noble, G.K.; Clausen, H.J. The aggregation behavior of *Storeria dekayi* and other snakes, with especial reference to the sense organs involved. *Ecological Monographs*. 6: 269-316; 1936.
- Obbard, M.E.; Brooks, R.J. Nesting migrations of the snapping turtle (*Chelydra serpentina*). *Herpetologica*. 36: 158-162; 1980.
- Oldham, R.S. Spring movements in the American toad, *Bufo americanus*. *Canadian Journal of Zoology*. 44: 63-100; 1966.
- Oliver, J.A. The natural history of North American amphibians and reptiles. Princeton, NJ: D. Van Nostrand Co., Inc.; 1955.
- Oplinger, C.S. Food habits and feeding activity of recently transformed and adult *Hyla c. crucifer* (Wied). *Herpetologica* 23: 209-217; 1967.
- Organ, J.A. Studies of the local distribution, life history, and population dynamics of the salamander genus *Desmognathus* in Virginia. *Ecological Monographs*. 31(2): 189-220; 1961.
- Palmer, E.L. *Fieldbook of natural history*. New York: McGraw-Hill; 1949.
- Pearse, A.S. The abundance and migration of turtles. *Ecology*. 4: 24-28; 1923.
- Pearson, P.G. Population ecology of the spadefoot toad, *Scaphiopus h. holbrooki*. *Ecological Monographs*. 25: 233-267; 1955.
- Petersen, R.C. Connecticut's venomous snakes. Hartford, CT: Connecticut Geological and Natural History Survey Bull. 103: 1-40; 1970.
- Pope, C.H. *Turtles of the United States and Canada*. New York: Alfred A. Knopf; 1939.
- Pope, C.H. *Amphibians and reptiles of the Chicago area*. Chicago, IL: Chicago Natural History Museum Press; 1944.
- Pough, F.H. Acid precipitation and embryonic mortality of spotted salamanders (*Ambystoma maculatum*). *Science*. 192: 68-70; 1976.
- Pough, F.H.; Wilson, R.E. Acid precipitation and reproductive success of *Ambystoma* salamanders. In: *Proceedings of the 1st International Symposium on Acid Precipitation and the Forest Ecosystem*; 1975 May 12-15; Columbus, OH. Gen. Tech. Rep. NE-23. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1976: 531-544.
- Powders, V.N.; Tietjen, W.L. The comparative food habits of sympatric and allopatric salamanders, *Plethodon glutinosus* and *Plethodon jordani* in eastern Tennessee and adjacent areas. *Herpetologica*. 30: 167-175; 1974.

- Rand, A.S. Leopard frogs in caves in winter. *Copeia*. 1950: 324; 1950.
- Raney, E.C. Summer movements of the bullfrog, *Rana catesbeiana* (Shaw), as determined by the jaw-tag method. *American Midland Naturalist*. 23: 733-745; 1940.
- Raney, E.C.; Roecker, R.M. Food and growth of two species of watersnakes from western New York. *Copeia*. 1947: 171-174.
- Reinert, H.K. Habitat separation between sympatric snake populations. *Ecology*. 65: 478-486; 1984.
- Richmond, N.D. Life history of *Scaphiopus h. holbrookii* (Harlan). Pt. I: Larval development and behavior. *Ecology*. 28: 53-67; 1947.
- Ries, K.M.; Bellis, E.D. Spring food habits of the red-spotted newt in Pennsylvania. *Herpetologica*. 22: 152-155; 1966.
- Risely, P.L. Observations on the natural history of the common musk turtle, *Sternotherus odoratus* (Latreille). *Papers of the Michigan Academy of Science Arts and Letters*. 17: 685-711; 1932.
- Rossman, D.A. *Thamnophis sauritus* (Linnaeus). Catalogue of American Amphibians and Reptiles. 99.1-99.2; 1970.
- Sayler, A. The reproductive ecology of the red-backed salamander, *Plethodon cinereus*, in Maryland. *Copeia*. 1966(2): 183-193; 1966.
- Schaaf, R.T., Jr.; Smith, P.W. *Rana palustris* (LeConte). Catalogue of American Amphibians and Reptiles. 117.1-117.3; 1971.
- Schlauch, F.C. Agonistic behavior in a suburban Long Island population of the smooth green snake, *Opheodrys vernalis*. *Engelhardtia*. 6: 25-26; 1975.
- Schmidt, K.P.; Davis, D.D. Field book of snakes. New York, NY: G.P. Putnam and Sons; 1941.
- Seibert, H.C.; Hagen, C.W., Jr. Studies on a population of snakes in Illinois. *Copeia*. 1947(1): 6-22; 1947.
- Semlitsch, R.D. Geographic and local variation in population parameters of the slimy salamander (*Plethodon glutinosus*). *Herpetologica*. 36: 6-16; 1980a.
- Semlitsch, R.D. Terrestrial activity and summer home range of the mole salamander (*Ambystoma talpoideum*). *Canadian Journal of Zoology*. 59: 315-322; 1980b.
- Sexton, O.J. Spatial and temporal movements of a population of the painted turtle, *Chrysemys picta marginata* (Agassiz). *Ecological Monographs*. 29: 113-140; 1959.
- Shoop, C.R. Orientation of *Ambystoma maculatum*: Movements to and from breeding ponds. *Science*. 149: 558-559; 1965.
- Shoop, C.R. Migratory orientation of *Ambystoma maculatum*: Movements near breeding ponds and displacements of migrating individuals. *Biological Bulletin*. 135: 230-238; 1968.
- Shoop, C.R. Yearly variation in larval survival of *Ambystoma maculatum*. *Ecology*. 55: 440-444; 1974.
- Shoop, C.R.; Gunning, G.E. Seasonal activity and movements of *Necturus* in Louisiana. *Copeia*. 1967: 732-737.
- Smith, H.M. Handbook of lizards. Ithaca, NY: Cornell University Press; 1946.
- Smith, H.M. Handbook of amphibians and reptiles. Kansas. 2d ed. Misc. Publ. No. 9. Topeka, KS: Museum of Natural History, University of Kansas; 1956.
- Smith, H.M. Amphibians of North America: A guide to field identification. Racine, WI: Western Publishing Co., Inc.; 1978.
- Smith, P.W. The amphibians and reptiles of Illinois. *Illinois Natural History Survey Bulletin*. 28: 1-298; 1961.
- Smith, P.W. *Plethodon cinereus*. Catalogue of American Amphibians and Reptiles. 5.1-5.3; 1963.
- Stewart, D. Canadian endangered species. Toronto, ON: Gage Publications; 1974.
- Stewart, M.M. The separate effects of food and temperature differences on development of marbled salamander larvae. *Journal of the Elisha Mitchell Scientific Society*. 72: 47-56; 1956b.
- Stewart, M.M. Certain aspects of the natural history and development of the northern two-lined salamander, *Eurycea b. bislineata* (Green), in the Ithaca, New York region. Ithaca, NY: Cornell University; 1956. Ph.D. dissertation.
- Stewart, M.M. Biology of the Allegany Indian Reservation and vicinity. Pt. 3: The amphibians, reptiles and mammals. *New York State Museum Science Service Bulletin*. 383: 63-88; 1961.
- Stewart, M.M. Habitat management in the Adirondack Park. *New York Environmental News* 2(17): 1-2; 1971.
- Stewart, M.M.; Rossi, J. The Albany Pine Bush: A northern outpost for southern species of amphibians and reptiles in New York. *American Midland Naturalist*. 106: 282-292; 1981.
- Stewart, M.M.; Sandison, P. Comparative food habits of sympatric mink frogs, bullfrogs, and green frogs. *Journal of Herpetology*. 6: 241-244; 1972.
- Stickel, L.F. Population and home range relationships of the box turtle, *Terrapene c. carolina* (Linnaeus). *Ecological Monographs*. 20: 351-378; 1950.
- Stickel, L.F.; Stickel, W.H.; Schmid, F.C. Ecology of a Maryland population of black rat snakes (*Elaphe obsoleta*). *American Midland Naturalist*. 103: 1-18; 1980.
- Stickel, W.H.; Cope, J.B. The home ranges and wanderings of snakes. *Copeia*. 1947: 127-136; 1947.
- Stille, W.T. The nocturnal amphibian fauna of the southern Lake Michigan beach. *Ecology*. 33: 149-160; 1952.
- Stille, W.T. Eggs of the salamander *Ambystoma jeffersonianum* in the Chicago area. *Copeia*. 1954: 300; 1954.
- Stone, W.B.; E. Kiviat; Butkas, S.A. Toxicants in snapping turtles. *New York Fish and Game Journal*. 27: 1-50; 1980.
- Storer, D.H. A report on the reptiles of Massachusetts. *Boston Journal of Natural History*. 3: 1-64; 1840.
- Strang, C.A. Spatial and temporal activity patterns of two territorial turtles. *Journal of Herpetology*. 17: 47; 1983.
- Surface, H.A. The serpents of Pennsylvania. *Pennsylvania Department of Agriculture, Division of Zoology Bulletin*. 4: 113-303; 1906.

- surface, H.A. First report on the economic features of the turtles of Pennsylvania. Pennsylvania Department of Agriculture, Division of zoology, Bulletin. 6: 105-196; 1908.
- surface, H.A. The amphibians of Pennsylvania. Bimonthly Pennsylvania Department of Agriculture, Division of Zoology, Bulletin. 3(3-4): 65-152, 1-11; 1913.
- Sub, F.B. The distribution of the red-backed salamander, *Plethodon c. cinereus*, within the soil. Ecology. 42: 681-698; 1961.
- Tompson, E.L.; Gates, J.E.; Taylor, G.J. Distribution and breeding habitat selection of the Jefferson salamander, *Ambystoma jeffersonianum*, in Maryland. Journal of Herpetology. 14: 13-20; 1980.
- Treley, S.G. Size-fecundity relationships and their evolutionary implications in five desmognathine salamanders. Evolution. 22: 806-816; 1968.
- Treley, S.G. Aspects of the reproductive and population ecology of *Desmognathus ochropheus* in the southern Appalachian mountains. Ann Arbor, MI: University of Michigan; 1970. Ph.D. dissertation.
- Treley, S.G. Aspects of parental care and embryonic development in *Desmognathus ochropheus*. Catalogue of American Amphibians and Reptiles. 129.1-129.4; 1973.
- Treley, S.G.; Lundrigan, B.L.; Brower, L.P. Erythrism and mimicry in the salamander *Plethodon cinereus*. Herpetologica. 38(3): 409-417; 1982.
- Ukle, D.W. Geographic variation in reproduction, size, sex ratio, and maturity of *Sternotherus odoratus* (Testudinata: Chelydridae). Ecology. 42: 68-76; 1961.
- Upido, H.; Clausen, R.T. Amphibians and reptiles of eastern Quebec. Copeia. 1938: 117-125; 1938.
- Usher, F.M.; Cottom, C.; Clarke, T.E. Food of snakes of the George Washington National Forest, Virginia. Trans. 4th Am. Nat. Resour. Wildl. Conf. 1939: 605-622.
- U.S. Department of Interior, Fish and Wildlife Service. Endangered and threatened wildlife and plants — republication of list of species. Federal Register. 45(99): 33768-33781; 1980.
- Uzell, T.M., Jr. Relations of the diploid and triploid species of the *Ambystoma jeffersonianum* complex (Amphibia, Caudata). Copeia. 1964: 257-300; 1964.
- Uzell, T.M. *Ambystoma jeffersonianum*. Catalogue of American Amphibians and Reptiles. 47.1-47.2; 1967a.
- Uzell, T.M. *Ambystoma laterale*. Catalogue of American Amphibians and Reptiles. 48.1-48.2; 1967b.
- Uzell, T.M. *Ambystoma platineum*. Catalogue of American Amphibians and Reptiles. 49.1-49.2; 1967c.
- Uzell, T.M. *Ambystoma tremblayi*. Catalogue of American Amphibians and Reptiles. 50.1-50.2; 1967d.
- Vinegar, A.; Friedman, M. *Necturus* in Rhode Island. Herpetologica. 23: 51; 1967.
- Wacasey, J.W. An ecological study of two sympatric species of salamanders, *Ambystoma maculatum* and *Ambystoma jeffersonianum*, in southern Michigan. East Lansing, MI: Michigan State university; 1961. Ph.D. dissertation.
- Warfel, H.E. Notes on the occurrence of *Necturus maculosus* (Rafinesque) in Massachusetts. Copeia. 1936: 237; 1936.
- Wasserman, A.O. *Scaphiopus holbrookii* (Harlan). Catalogue of American Amphibians and Reptiles. 70.1-70.4; 1968.
- Webb, R.G. Observations on the life histories of turtles (genus *Pseudemys* and *Graptemys*) in Lake Texoma, Oklahoma. American Midland Naturalist. 56: 193-214; 1961.
- Webb, R.G. *Trionyx spiniferus* (LeSueur). Catalogue of American Amphibians and Reptiles. 140.1-140.4; 1973.
- Wells, K.D. Multiple egg clutches in the green frog (*Rana clamitans*). Herpetologica. 32: 85-87; 1976.
- Wells, K.D. Territoriality and male mating success in the green frog (*Rana clamitans*). Ecology. 58: 750-762; 1977.
- Wells, K.D.; Wells, R.A. Patterns of movement in a population of the slimy salamander, *Plethodon glutinosus*, with observations on aggregations. Herpetologica. 32: 156-162; 1976.
- Werner, J.K. Notes on the reproductive cycle of *Plethodon cinereus* in Michigan. Copeia. 1971: 161-162; 1971.
- Whitford, A.G.; Vinegar, A. Homing, survivorship, and overwintering of larvae in *Ambystoma maculatum*. Copeia. 1966: 515-519; 1966.
- Wilder, I.W. The life history of *Desmognathus fusca*. Biological Bulletin. 24: 251-342; 1913.
- Wilder, I.W. On the breeding habits of *Desmognathus fusca*. Biological Bulletin. 32: 13-20; 1917.
- Wilder, I.W. The relation of growth to metamorphosis in *Eurycea bislineata* (Green). Journal of Experimental Zoology. 40: 1-112; 1924.
- Williams, J.E. Homing behavior of the painted turtle and musk turtle in a lake. Copeia. 1952: 76-82; 1952.
- Williams, K.L. Systematics and natural history of the American milk snake, *Lampropeltis triangulum*. Milwaukee, WI: Milwaukee Public Museum Press; 1978.
- Williams, P.K. Seasonal movements and population dynamics of four sympatric mole salamanders, genus *Ambystoma*. Bloomington, IN: Indiana University; 1973. Ph.D. dissertation.
- Williams, T.K.; Christiansen, J.L. The niches of two sympatric softshell turtles, *Trionyx muticus* and *Trionyx spiniferus*, in Iowa, Journal of Herpetology. 15: 303-308; 1982.
- Wilson, L.D. *Coluber constrictor* (Linnaeus). Catalogue of American Amphibians and Reptiles. 218.1-218.4; 1978.

- Wilson, R.E. An ecological study of *Ambystoma maculatum* and *Ambystoma jeffersonianum*. Ithaca, NY: Cornell University; 1976. Ph.D. dissertation.
- Wood, T.J. Observations on the complements of ova and nesting of the four-toed salamander in Virginia. *American Naturalist*. 87: 77-86; 1953.
- Woodward, B.S. Local intraspecific variation in clutch parameters in the spotted salamander (*Ambystoma maculatum*). *Copeia*. 1982(1): 157-160; 1982.
- Wright, A.H.; Allen, A.A. The early breeding habits of *Ambystoma punctatum*. *American Midland Naturalist*. 43: 687-692; 1909.
- Wright, A.H.; Wright, A.A. Handbook of frogs and toads. Ithaca, NY: Comstock; 1949.
- Wright, A.H.; Wright, A.A. Handbook of snakes. 2 Vols. Ithaca, NY: Comstock; 1957.
- Zehr, D.R. Stages in the development of the common garter snake, *Thamnophis sirtalis*. *Copeia*. 1962: 327-329; 1962.
- Zenisek, C.J. A study of the natural history and ecology of the leopard frog, *Rana pipiens* Schreber. Columbus, OH: Ohio State University; 1964. Ph.D. dissertation.

BIRDS

This section provides information on the life history, distribution, and habitat associations of birds in New England. Nomenclature is from the 6th edition of the *Checklist of North American Birds* (American Ornithologists' Union 1983), and species are arranged in phylogenetic order. A.O.U. (American Ornithologists' Union) numbers are also provided; originally used to standardize the marking of collected sets of eggs, they have long been used to code bird species' names. The increased use of computer data bases makes these numbers vitally important today. All inland species are included, as are marshland birds that occur along the Atlantic Coast. We have omitted the strictly marine species, but have included some species usually associated with the coast in New England but that also occur inland,

such as the Yellow-crowned Night Heron (*Nycticorax nycticorax*), Northern Pintail (*Anas acuta*), and Herring Gull (*Larus argentatus*).

Information in this section comes from extensive literature searches, reviews by acknowledged experts, and, for forest birds particularly, continuing research. Birds are by far the best known class of vertebrates included in this publication—New England has a rich avifauna that has been studied for many years by eminent ornithologists. The dedication that drove William Brewster, Edward Howe Forbush, and Ludlow Griscom continues to the present day; New England's birdlife has probably been studied more fully than that of any other region in the continental United States.

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Icterinae

Dolichonychini

Bobolink (<i>Dolichonyx oryzivorus</i>)	
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Agelaiini

Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	
Eastern Meadowlark (<i>Sturnella magna</i>)	
Rusty Blackbird (<i>Euphagus carolinus</i>)	
Common Grackle (<i>Quiscalus quiscula</i>)	
Brown-headed Cowbird (<i>Molothrus ater</i>)	

Icterini

Orchard Oriole (<i>Icterus spurius</i>)	
Northern Oriole (<i>Icterus galbula</i>)	

Fringillidae

Carduelinae

Pine Grosbeak (<i>Pinicola enucleator</i>)	
Purple Finch (<i>Carpodacus purpureus</i>)	
House Finch (<i>Carpodacus mexicanus</i>)	
Red Crossbill (<i>Loxia curvirostra</i>)	
White-winged Crossbill (<i>Loxia leucoptera</i>)	
Common Redpoll (<i>Carduelis flammea</i>)	
Hoary Redpoll (<i>Carduelis hornemanni</i>)	
Pine Siskin (<i>Carduelis pinus</i>)	
American Goldfinch (<i>Carduelis tristis</i>)	
Evening Grosbeak (<i>Coccothraustes vespertinus</i>)	

Passeridae

House Sparrow (<i>Passer domesticus</i>)	
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SPECIES	Special habitat needs	Local occurrence											
		S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
Great Blue Heron <i>Ardea herodias</i>	Undisturbed traditional rookery												
Green-backed Heron <i>Butorides striatus</i>													
Wood Duck <i>Aix sponsa</i>	Trees at least 16" dbh with large cavities and 4" diameter entrance holes												
American Black Duck <i>Anas rubripes</i>	Wooded wetlands, stream banks (inland)												
Common Goldeneye <i>Bucephala clangula</i>	Cavity trees with minimum dbh of 20"; clear, cold, shallow water												
Bufflehead <i>Bucephala albeola</i>	Cavity trees, usually with holes made by flickers or pileated woodpeckers												
Hooded Merganser <i>Lophodytes cucullatus</i>	Undisturbed wooded areas with cavity trees (15" dbh min.); clear fresh water												
Common Merganser <i>Mergus merganser</i>	Large cavity trees at water's edge												
Turkey Vulture <i>Cathartes aura</i>	Forest clearings												
Bald Eagle <i>Haliaeetus leucocephalus</i>	Large, undisturbed water bodies containing fish, large living trees near shore												
Sharp-shinned Hawk <i>Accipiter striatus</i>	Extensive undisturbed open mixed woodlands												
Seasonal use		B	BF	W	WF	B	BF	W	WF	B	BF	W	WF
Eastern hemlock													
Red spruce													
Red spruce-Balsam fir													
Eastern white pine													
Balsam fir													
White pine— Northern red oak— Red maple													
Northern red oak													
Red maple													
Northern hardwoods													
Paper birch													
Aspen													

SPECIES	Special habitat needs	Local occurrence											
		B	BF	W	WF	B	BF	W	WF	B	BF	W	WF
Wild Turkey <i>Meleagris gallopavo</i>	Open, mast-producing woodlands, large conifers for roosting, woodland clearings												
Northern Bobwhite <i>Colinus virginianus</i>	Brushy field edges, well-drained sandy or loamy soils												
American Woodcock <i>Scolopax minor</i>	Fertile moist soil containing earthworms, clearings and dense swales												
Mourning Dove <i>Zenaidura macroura</i>	Open land with bare ground												
Black-billed Cuckoo <i>Coccyzus erythrophthalmus</i>	Low, dense thickets												
Yellow-billed Cuckoo <i>Coccyzus americanus</i>	Low, dense thickets												
Eastern Screech-Owl <i>Otus asio</i>	Cavity trees (12" dbh minimum)												
Great Horned Owl <i>Bubo virginianus</i>	Large abandoned hawk nests, large tree cavities												
Northern Hawk-Owl <i>Surnia ulula</i>	Open coniferous or mixed woodland, burns with standing stubs												
Barred Owl <i>Strix varia</i>	Cool, damp lowlands; cavity trees with minimum dbh of 20"												
Great Gray Owl <i>Strix nebulosa</i>	Meadows, swamps near woodlands												
Seasonal use		S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
Aspen													
Paper birch													
Northern hardwoods													
Red maple													
Northern red oak													
White pine— Northern red oak— Red maple													
Balsam fir													
Eastern white pine													
Red spruce - Balsam fir													
Red spruce													
Eastern hemlock													

SPECIES	Special habitat needs	Local occurrence
Long-eared Owl <i>Asio otus</i>	Dense conifer thickets in open country	<div> <div> <div>S</div> <div>Sp</div> <div>St</div> <div>L</div> </div> <div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div> </div>
Boreal Owl <i>Aegolius funereus</i>	Cavity trees, often with large woodpecker holes	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Northern Saw-whet Owl <i>Aegolius acadicus</i>	Cavity trees with minimum dbh of 12" near forest clearings	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Common Nighthawk <i>Chordeiles minor</i>		<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Whip-poor-will <i>Caprimulgus vociferus</i>	Ungrazed woodlands with openings	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Ruby-throated Hummingbird <i>Archilochus colubris</i>	Flowers, preferably red	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Red-headed Woodpecker <i>Melanerpes erythrocephalus</i>	Cavity trees in savanna or open country	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Red-bellied Woodpecker <i>Melanerpes carolinus</i>	Extensive mature woodlands with dead trees or trees with large dead limbs	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Yellow-bellied Sapsucker <i>Sphyrapicus varius</i>	Trees with minimal dbh of 10" especially aspens containing sound decayed wood	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Downy Woodpecker <i>Picoides pubescens</i>	Trees, limbs with decay column (minimum dbh 6")	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>
Hairy Woodpecker <i>Picoides villosus</i>	Trees, limbs with decay column (minimum dbh 10")	<div> <div>B</div> <div>BF</div> <div>W</div> <div>WF</div> </div>

SPECIES	Special habitat needs
Northern Mockingbird <i>Mimus polyglottos</i>	Low thickets; high perches; persistent fruits
Brown Thrasher <i>Toxostoma rufum</i>	Hardwood forest-field ecotone
Bohemian Waxwing <i>Bombycilla garrulus</i>	Open country, shrubs, trees, thickets with persistent fruits (winter)
Cedar Waxwing <i>Bombycilla cedrorum</i>	Open country with scattered trees, thickets with persistent fruits (winter)
Northern Shrike <i>Lanius excubitor</i>	Scattered trees or shrubs in an open country
Loggerhead Shrike <i>Lanius ludovicianus</i>	Open country with short grasses, scattered trees, shrubs
European Starling <i>Sturnus vulgaris</i>	Cavity trees with 10" minimum dbh
White-eyed Vireo <i>Vireo griseus</i>	Low shrubs, thickets
Solitary Vireo <i>Vireo solitarius</i>	Mixed or predominantly coniferous woodland
Yellow-throated Vireo <i>Vireo flavifrons</i>	Mature deciduous forest
Warbling Vireo <i>Vireo gilvus</i>	Scattered deciduous trees, shade trees

SPECIES	Special habitat needs	Local occurrence
American Redstart <i>Setophaga ruticilla</i>		
Prothonotary Warbler <i>Protonotaria citrea</i>	Tree cavities in moist hardwood forest	
Worm-eating Warbler <i>Helmitheros vermivorus</i>	Well developed understory	
Ovenbird <i>Seiurus aurocapillus</i>		
Northern Waterthrush <i>Seiurus noveboracensis</i>	Cool, shaded wet ground with shallow pools	
Louisiana Waterthrush <i>Seiurus motacilla</i>	Woodlands with flowing water	
Mourning Warbler <i>Oporornis philadelphia</i>	Extensive stands hardwood regeneration	
Common Yellowthroat <i>Geothlypis trichas</i>		
Hooded Warbler <i>Vireonia citrina</i>	Dense understory	
Wilson's Warbler <i>Vireonia pusilla</i>	Cold shrub swamps, bogs	
Canada Warbler <i>Vireonia canadensis</i>	Dense deciduous or ericaceous understory	

SPECIES	Special habitat needs	Local occurrence
Purple Finch <i>Carpodacus purpureus</i>	Coniferous trees	
House Finch <i>Carpodacus mexicanus</i>	Open ground with low seed-producing plants	
Red Crossbill <i>Loxia curvirostra</i>	Northern coniferous trees	
White-winged Crossbill <i>Loxia leucoptera</i>	Northern coniferous trees	
Common Redpoll <i>Carduelis flammea</i>	Open country	
Hoary Redpoll <i>Carduelis hornemanni</i>	Open country	
Pine Siskin <i>Carduelis pinus</i>	Conifers	
American Goldfinch <i>Carduelis tristis</i>	Open, weedy fields with scattered small trees	
Evening Grosbeak <i>Coccothraustes vespertinus</i>	Spruce and fir forest (breeding season)	

SPECIES OCCURRENCE AND UTILIZATION, BY HABITAT NONFORESTED

Local occurrence	SPECIES	Special habitat needs	Seasonal use												Terrestrial								Wetland/Deep Water												Other																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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Northern Goshawk <i>Accipiter gentilis</i>	Extensive mature mixed woodlands.		B																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

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	Spruce Grouse <i>Dendragapus canadensis</i>	Coniferous forest																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

SPECIES	Special habitat needs
Yellow-billed Cuckoo <i>Coccyzus americanus</i>	Low, dense thickets
Common Barn-Owl <i>Tyto alba</i>	Barns, silos, deserted buildings, tree cavities
Eastern Screech-Owl <i>Otus asio</i>	Cavity trees (12" dbh minimum)
Great Horned Owl <i>Bubo virginianus</i>	Large abandoned hawk nests, large tree cavities
Snowy Owl <i>Nyctea scandiaca</i>	Open Country
Northern Hawk-Owl <i>Surnia ulula</i>	
Barred Owl <i>Strix varia</i>	Cool, damp lowlands, cavity trees with minimum dbh of 20"
Great Gray Owl <i>Strix nebulosa</i>	
Long-eared Owl <i>Asio otus</i>	Dense conifer thickets in open country
Short-eared Owl <i>Asio flammeus</i>	Extensive open grasslands, dunes.
Boreal Owl <i>Aegolius funereus</i>	

SPECIES	Special habitat needs	Seasonal use				Terrestrial								Wetland Deep Water												Other																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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SPECIES	Special habitat needs	Seasonal use												Terrestrial										Wetland/Deep Water												Other											
		B	BF	W	WF	B	BF	W	WF	B	BF	W	WF	Alpine	Krummholz	Orchard	Savanna	Pasture	Shrub/old field	Forb	Grass	Cultivated	Upland field	Lake	Pond	Bog	Shrub swamp	Deep marsh	Shallow marsh	Sedge meadow	Palustrine	Stream	River	Riparian	Estuary/salt marsh	Coastal beach/rocks	Bay, ocean	Marine	Stable bank	Ledge, cliff	Cave	Structure, building	Derelict building, debris				
Blue Jay <i>Cyanocitta cristata</i>																																															
American Crow <i>Corvus brachyrhynchos</i>																																															
Fish Crow <i>Corvus ossifragus</i>																																															
Common Raven <i>Corvus corax</i>	Cliffs																																														
Black-capped Chickadee <i>Parus atricapillus</i>	Cavity trees or dead stubs in small woodlands, clearings or open woodlands																																														
Boreal Chickadee <i>Parus hudsonicus</i>	Softwood snags, stubs																																														
Tufted Titmouse <i>Parus bicolor</i>	Cavity trees at least 8" dbh																																														
Red-breasted Nuthatch <i>Sitta canadensis</i>	Cavity trees in mixed or coniferous woods (minimum dbh 12")																																														
White-breasted Nuthatch <i>Sitta carolinensis</i>	Cavity trees in hardwoods or mixed woods (minimum dbh 12")																																														
Brown Creeper <i>Certhia americana</i>	Woodland trees with sloughing or loose bark																																														
Carolina Wren <i>Thryothorus ludovicianus</i>	Cavity tree amid brushy vegetation																																														

Other	Derelict building, debris																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Common Loon

(*via immer*)

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Range

- Breeding
- Winter



SIZE: Breeding: Alaska and n. Canada s. to c. Massachusetts, Montana, and California. Winter: Atlantic coast from Newfoundland to the Gulf of Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to locally common in breeding season. Common along coast in winter. Subadults common along northeast coast in summer.

HABITAT: Breeding: Large and small freshwater lakes in open and densely forested areas. Nest on lakes as small as 2 acres. Wintering: Coastal bays and inlets from Maritime Provinces south. Occasional on fresh water inland in southern New England until freeze-up.

SPECIAL HABITAT REQUIREMENTS: Bodies of water with stable water levels and little or no human disturbance. Long stretch of water for flight take-off. Islets for nesting; shallow coves for rearing of young (Hammond and Wood 1977).

REPRODUCTION: Egg dates: May 15 to July 16. Peak: June, New Brunswick (Bull 1974:51). Clutch size: 1 to 3, typically 2. Incubation period: 28 to 29 days. Nestling period: 1 day (social). Broods per year: 1. Age at sexual maturity: 2 to 3 years. Nest site: Nest is placed on ground at water's edge, usually on sand, rocks, or other firm substrate. Prefers small islands to shore but nests along protected bays, on promontories and small peninsulas. Islands provide better protection from mammalian predators than shore sites.

TERRITORY SIZE: 15 to 100 or more acres (6.1 to 40.5 ha) per pair in Minnesota (Olson and Marshall 1952), to 25 ha (62 acres) (Sjolander and Agren 1972).

HOME RANGE: Probably same as territory.

SAMPLE DENSITIES: Average 2 birds per square mile (0.8 birds/km²) over a 60-square-mile (155-km²) area in Minnesota (Olson and Marshall 1952) but highly variable depending on nest site availability.

FORAGING: Major foods: Fish (staple), amphibians, insects, aquatic plants, crustaceans, mollusks, leeches. Substrates: Water, pond and lake bottoms. Techniques: Swimming; diving in deep water; extending head and neck below surface, goose-like, in shallow water.

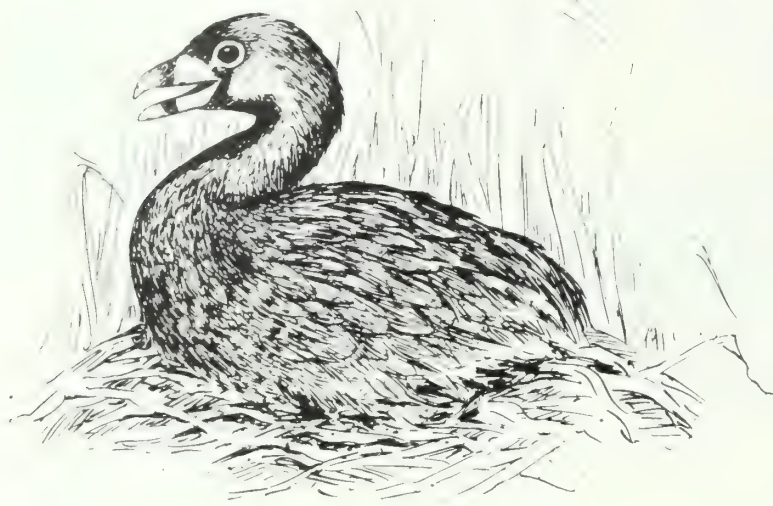
COMMENTS: Most feeding is done on the territory which probably accounts for the large territory. Although fish is eaten in quantity when available, it does not seem to be a required food because loons are known to breed at fishless ponds (Pough 1951:3). Same nest sites are often occupied year after year, presumably by same pair. Disturbance by canoeists and fishermen is a serious problem during nesting. Nesting is often unsuccessful if water level fluctuates.

KEY REFERENCES: Bent 1919, Hammond and Wood 1977, Palmer 1962, Vermeer 1973.


Pied-billed Grebe

(*Podilymbus podiceps*)

A.O.U. No. 006.0



Range

 Breeding



RANGE: Breeding: Throughout most of the United States (excluding Alaska) and s. Canadian provinces. Winter: New York s. along Atlantic coast; inland across coastal states. Occasional in winter in s. New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common throughout range in the Northeast during breeding season.

HABITAT: Breeding: Ponds with heavy emergent vegetation, marshes and marshy inlets with areas of open water (Faaborg 1976), sluggish streams with protective vegetation overhanging banks, reed-bordered swamps with open water. Wintering: Interior rivers and open lakes, tidal creeks and estuaries. Prefers fresh water.

SPECIAL HABITAT REQUIREMENTS: Birds need open water to become airborne, some aquatic vegetation (type not important) (Palmer 1962:108).

NESTING: Egg dates: April 21 to July 2, New York (Bull 1974:56). Clutch size: 2 to 10, typically 4 to 7. Incubation period: 23 to 24 days. Nestling period: 1 or 2 days (precocial). Broods per year: 1. Nest site: Usually built over shallow water anchored to the stems of emergent vegetation, less often located in shrubs such as sweet gale and buttonbush. A solitary nester but occasionally several nests are widely spaced at large ponds (Palmer 1962:108).

TERRITORY SIZE: Defends area within a 150-foot (45.7 m) radius (or more) of nest in Iowa potholes (Glover 1953).

HOME RANGE: About twice the size of nesting territory (Glover 1953).

SAMPLE DENSITIES: Generally 1 pair on ponds up to 4 acres (4 ha) (Palmer 1962:108). Nests may be spaced to 30 feet (4.6 to 9.1 m) apart at larger ponds.

FORAGING: Major foods: Aquatic insects, small fish, snails, aquatic worms, crayfish, shrimp, amphibians, leeches. Minor feed: aquatic vegetation. Substrate: Water, bottoms of bodies of water. Techniques: Swimming, diving.

COMMENTS: Birds are solitary or seen in pairs or small groups (to 10 individuals) outside of breeding season.

KEY REFERENCES: Bent 1919, Chabreck 1963, Forb 1929, Glover 1953, Palmer 1962.


American Bittern

(*Icthyophaga lentiginosa*)

O.U. No. 190.0



Range

 Breeding



AGE: Breeding: Newfoundland w. to British Columbia, s. to New Jersey, Arizona, and s. California. Winter: Coastal New York, w. to s. British Columbia, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common and widespread.

HABITAT: Breeding: Fresh (sometimes brackish and salt water) marshes, meadows, swamps and bogs, especially those having tall vegetation such as cattails and bulrushes, sluggish rivers and streams with dense border vegetation. Wintering: Coastal wetlands.

SPECIAL HABITAT REQUIREMENTS: Tall marsh vegetation such as cattails and bulrushes in areas with little or no human disturbance.

REPRODUCTION: Egg dates: May 10 to June 29, New York (Bull 1977:90). Clutch size: 3 to 7, typically 4 to 5. Incubation period: About 24 days. Nestling period: About 14 days. Reproducts per year: Probably 1. Age at sexual maturity: Unknown (Palmer 1962:502). Nest site: Dry or wet ground near or in marshes, bogs, swamps. Usually well

hidden in tall vegetation such as reeds, cattails, and so on, usually several inches above the water. Rarely in bushes or trees. Solitary nester.

SAMPLE DENSITIES: 5 nests on one slough less than 160 acres (64.8 ha) in Saskatchewan (Bent 1926:75). 2 nests on 5 acres (2.0 ha) of cordgrass meadow in Minnesota (Vesall 1940).

FORAGING: Major foods: Frogs (preferred), reptiles, crustaceans (crayfish, crabs), shellfish, insects, small fish, small mammals, spiders. Substrates: Water, shallow bottoms, aquatic vegetation. Techniques: Stand and wait, walk slowly (Kushlan 1976).

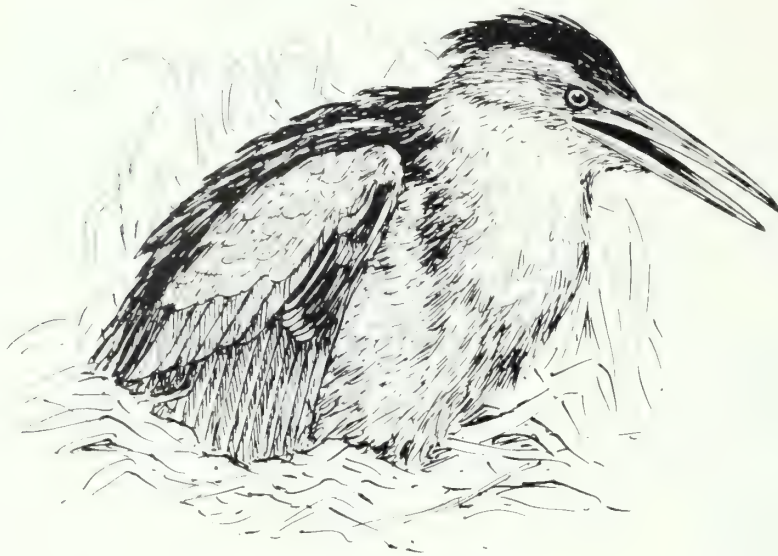
COMMENTS: So shy, bitterns are seldom seen. They are known to abandon a marsh at the slightest disturbance.

KEY REFERENCES: Bent 1926, Forbush 1929, Palmer 1962.


Least Bittern

(*Ixobrychus exilis*)

A.O.U. No. 191.0



Range

 Breeding



RANGE: Breeding: New Brunswick w. to Oregon, s. to South America. Winter: Georgia s. to Florida, w. to Texas and s. California, southward.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Fresh, brackish and, less frequently, salt water wetlands. Prefers marshes with tall vegetation such as cattails, sedges, and scattered bushes.

SPECIAL HABITAT REQUIREMENTS: Deep marshes with clumps of emergent vegetation.

NESTING: Egg dates: May 15 to July 10, New York (Bull 1974:91). Clutch size: 3 to 6, typically 4 to 5. Incubation period: 17 to 18 days. Nestling period: 10 to 14 days. Broods per year: 1 or 2. One in New England (Forbush 1929 V. 1:322). Age at sexual maturity: Unknown (Palmer 1962:496). Nest height: To 20 feet (6.1 m), typically 8 to 14 inches (20.3 to 35.6 cm) above water level. Nest site: Probably chosen by male. Usually located in dense stand of reeds, cattails, sedges or other marsh vegetation close to open water. The Least Bittern is usually a solitary nester.

TERRITORY SIZE: There is limited evidence of territoriality in Least Bitterns (Weller 1961).

SAMPLE DENSITIES: 15 nests were found in a 2-acre (0.8 ha) patch of rushes in Michigan (Wood 1951), but this

was exceptional. 19 nests were found in a 44-acre (18 ha) marsh (Kent 1951 in Palmer 1962:496). 1 nest per 1.6 acres (1.6 ha) of useable vegetation (Beecher 1942).

FORAGING: Major foods: Small fishes, crustaceans (mainly crayfish), frogs and salamanders, reptiles, insects, occasionally shrews and mice. Substrates: Marsh vegetation, shallow water. Techniques: Stand and wait, walk slowly (Kushlan 1976).

COMMENTS: Usually nests singly but may be collected with other Least Bitterns in favorable habitat. Marsh drainage, pollution, and insecticides have adversely affected parts of its range.

KEY REFERENCES: Bent 1926, Forbush 1929, Palmer 1962, Weller 1961.

Great Blue Heron

(*Ardea herodias*)

U. No. 194.0



Range

- Permanent
- Breeding



DISTRIBUTION: Breeding: Southern Canadian provinces, s. to Mexico. Winter: Massachusetts s. through coastal areas, w. across the s. half of the United States, s. to n. America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common (Maine) to rare (Massachusetts) in breeding season.

HABITAT: Breeding: Shallow shores of ponds, lakes, marshes, rivers, wet meadows, wooded swamps, fresh water, and marshes. Wintering: Mainly coastal areas on bare (snow-free) ground and open water.

SPECIAL HABITAT REQUIREMENTS: Generally require tall trees for nesting.

REPRODUCTION: Egg dates: April 15 to June 9, New York (Bull 1973). Clutch size: 3 to 7, typically 4. Incubation period: About 28 days (Bent 1926:106). Nestling period: About 60 days (Pratt 1970). Broods per year: 1. Age at sexual maturity: 2 years (Bent 1926:108). Nest height: 10 feet (3.0 m), typically high in large trees. Nest site: Varies with habitat. Usually in tall trees but may be on ground, rock ledges, and sea cliffs, or in shrubs. They are typically colonial nesters but may be solitary. A nest often repaired for use each season. Nest may be 100 feet from food sources.

TERRITORY SIZE: Sizes vary with habitat and stage of reproductive cycle. Colonial nesters defend small areas often restricted to the distance the bird can extend its neck and bill from the nest.

SAMPLE DENSITIES: Dozens of nests may be built in crown of a single tree. 131 active nests per 0.36 ha (0.9 acre) in Oregon (Werschkul et al. 1976).

FORAGING: Major foods: Aquatic and terrestrial insects, fishes, amphibians, reptiles, crustaceans, occasionally small birds and mammals. Substrates: Shallow water, muddy bottoms, grasses and weeds. Techniques: Stand and wait (Kushlan 1976, Willard 1977), walk slowly. Active pursuit is infrequent. Occasionally floats (Pough 1951:40). Preferred feeding habitat: Wet meadows, pastures.

COMMENTS: Individual feeding territories may be strongly defended during the nonbreeding season. Birds occasionally nest miles from food source. Commonly seen feeding on tidal flats during migration.

KEY REFERENCES: Bent 1926, Cottrille and Cottrille 1958, Palmer 1962, Pratt 1970.

Green-backed Heron

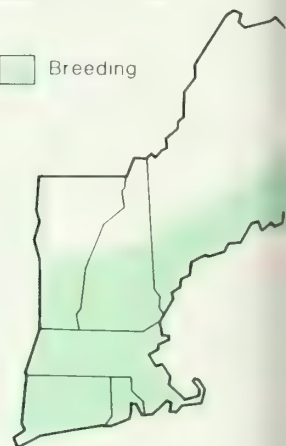
(*Butorides striatus*)

A.O.U. No. 201.0



Range

 Breeding



RANGE: Breeding: Nova Scotia w. to Oregon, s. to Central America. Winter: South Carolina to Florida, w. along Gulf States, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to common and widespread.

HABITAT: Breeding: Widely distributed—makes use of nearly all fresh and salt water habitats: ponds, lakes, rivers, streams, sloughs, marshes, wooded swamps, wet meadows.

NESTING: Egg dates: April 29 to August 4, New York (Bull 1974:85). Clutch size: 3 to 6, typically 4 to 5. Incubation period: 19 to 21 days. Nestling period: 16 to 17 days. Fledge when about 21 days old. Broods per year: 1 (rarely 2). Age at sexual maturity: 1 year. Nest height: 1 to 30 feet (0.3 to 9.1 m), typically 10 to 15 feet (3 to 4.5 m). Nest site: Varies, often nests near water—on a hummock in a marsh or in a tree—but also may nest away from water in trees of dry woodlands and orchards. Often chooses conifers but uses many hardwood trees or shrubs. Sometimes uses old nest.

TERRITORY SIZE: Male defends a large area upon arrival but territory decreases to within a few feet of the nest as season progresses. Female helps defend.

SAMPLE DENSITIES: Green Herons are solitary or colonial, nesting in small groups of up to 30 pairs (Pough 1951:47). Larger groups are unusual, although 70

breeding pairs were found on an area 240 feet (73.2 m) by 1,500 feet (457.3 m) long on Long Island, New York (Palmer 1962:419).

FORAGING: Major foods: Small fishes, crustaceans, mollusks, terrestrial and aquatic insects, reptiles, amphibians, spiders, leeches. Substrates: Shallow water, mudflats, low bottoms, wetland vegetation. Techniques: Stand and wait, walk slowly (Kushlan 1976).

COMMENTS: Separate feeding territories are vigorously defended by some individuals. Occasionally many birds use a common feeding ground.

KEY REFERENCES: Bent 1926, Kushlan 1976, Palmer 1962

Black-crowned Night-Heron

(*Nycticorax nycticorax*)

U. No. 202.0



Range

Permanent

Breeding



DISTRIBUTION: Breeding: Quebec w. to Oregon, s. to the Gulf of Mexico (excluding parts of Appalachian mountains) and South America. Winter: Southern New England w. to California, s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (coast) and rare (inland).

HABITAT: Breeding: Extremely varied. Occupies fresh, brackish, and salt water areas. Formerly very common in the Northeast breeding in large colonies. Almost disappeared in the 1960's, presumably from pesticides, today the Black-crowned Night-Heron is found mainly along the coast. Wintering: Coastal wetlands and islands.

REPRODUCTION: Egg dates: April 1 to July 12, New York (Bull 1978:66). Clutch size: 2 to 6, typically 3 to 5. Incubation period: 24 to 26 days. Age at first flight: About 42 days. Eggs per year: 1 (possibly 2). Age at sexual maturity: 3 to 4 years (occasionally 1 year, Gross 1923). Nest height: To 160 feet (48.8 m) (Oregon), typically 20 to 30 feet (6.1 to 9.1 m). Nest site: Varies from wooded areas to groves of pitch pine, spruce, red maple, and red oak swamps of alder and cedar and cattail marshes (prairies) known to breed in city parks. Occasionally constructs floating nest but most often builds in shrubs or trees.

TERRITORY SIZE: Unknown. Birds defend area immediately surrounding nest. Communal feeding areas reported on Long Island. Some birds defend feeding territories and roosting sites (Palmer 1962:478, 479).

SAMPLE DENSITIES: 400 pairs on Pea Patch Island in the Delaware River in 1976 (Buckley et al. 1976).

FORAGING: Major foods: Fishes, crustaceans, mollusks, worms, aquatic terrestrial insects, reptiles and amphibians, occasionally young birds and mammals. Substrates: Shallow water, muddy and sandy bottoms, dry ground. Techniques: Stand and wait, walk slowly (Kushlan 1976).

COMMENTS: Feeding activity is greatest at dawn and dusk with activity continuing into the early hours of darkness. Gregarious in all seasons.

KEY REFERENCES: Bent 1926, Forbush 1929, Gross 1923, Noble et al. 1938, Palmer 1962.


Yellow-crowned Night-Heron

(*Nycticorax violaceus*)

A.O.U. No. 203.0



Range

 Breeding



RANGE: Breeding: Eastern Massachusetts w. to Michigan (a few) and California s. to South America. May be extending breeding range in the Northeast—reports of sightings have increased in recent years. Winter: Central Florida w. to California, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common (coast) to rare inland.

HABITAT: Breeding: Islands in fresh and salt water, marshes, ponds, and wooded swamps where it nests in isolated groves of trees or bushes.

NESTING: Egg dates: April 30 to June 10, New York (Bull 1974:90). Clutch size: 3 to 6, typically 4 to 5. Incubation period: 24 days (Forbush 1929:342). Broods per year: Probably 1. Age at sexual maturity: Unknown (Palmer 1962:488). Nest height: To 50 feet (15.2 m). Nest site: Builds nest in isolated grove of trees or in brushy tangle at edge of pond, marsh, swamp. Rarely nests on the ground. Usually nests in small groups of 2 to 6 pairs at the edge of large heronries. Sometimes uses old nests.

TERRITORY SIZE: Sizes not known; birds defend an area for display, copulation, and nesting.

SAMPLE DENSITIES: 40 pairs on Pea Patch Island in Delaware River in 1976 (Buckley et al. 1976).

FORAGING: Major foods: Mainly crustaceans, e crabs and crayfish, mollusks. Sometimes takes reptiles, amphibians, small birds and mammals fishes. Substrates: Shallow water, shallow Techniques: Stand and wait; walk slowly 1976).

COMMENTS: Birds feed during the day and at night singly or in twos or threes.

KEY REFERENCES: Bent 1926, Palmer 1962, Pough 1976.

Glossy Ibis

(*Plegadis falcinellus*)

A.O.U. No. 185.0



Range



RANGE: Breeding: Locally in Maine s. along the Atlantic coast to Florida. Winter: Florida and the Gulf States s. to Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Fresh, brackish, and salt water. On New Jersey coast, birds nest in mixed stands of holly, red cedar, sumac, salt myrtle, bayberry, wild cherry, grape and cat brier that grow on barrier beaches. Favor shallow pools bordered by shrubs and emergent vegetation.

REPRODUCTION: Egg dates: March to late May (Palmer 1962:521). Clutch size: 3 to 5, typically 3 to 4. Incubation period: 21 days. Nestling period: About 14 days. Broods per year: 1. Age at sexual maturity: Unknown (Palmer 1962:520). Nest height: To 10 feet (3.0 m). Nest site: On ground in tall, dense vegetation such as cattails and sedges, in low bushes or in tops of low trees growing in water. Birds are colonial nesters—associating with herons and other ibises.

POPULATION DENSITIES: 600 pairs on Pea Patch Island in Delaware River in 1976 (Buckley et al. 1976).

FEEDING: Major foods: Crustaceans (especially crayfish), small snakes, cutworms and other grubs, grasshoppers, leeches. Substrates: Soft earth, shallow water, mudflats. Techniques: Probing. Preferred feeding habitat: Mud flats, flooded fields.

COMMENTS: The Glossy Ibis is extending its breeding range in the Northeast. It nested in Massachusetts in 1973 (new record) and over 100 pairs nested on coastal islands of the state in 1977 (Massachusetts Audubon Society 1977). Little is known about the birds' feeding habits in the Northeast.

KEY REFERENCES: Bent 1926, Miller and Burger 1978, Palmer 1962, Williams 1975a.



Mute Swan

(*Cygnus olor*)

A.O.U. No. 178.2



Range

-  Breeding
-  Winter



RANGE: Breeding: Small colonies exist in the Eastern United States, mainly along the northeastern coastline with largest numbers occurring in the Long Island area. Smaller groups range locally from New Hampshire and Massachusetts to Virginia. Winter: Same as above.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common (coast) to rare inland.

HABITAT: Breeding: Coastal bays, marshes and ponds having dense aquatic vegetation. Wintering: Inland birds may be forced to move to brackish or salt water areas if fresh waters freeze. Otherwise, birds remain in breeding territories.

SPECIAL HABITAT REQUIREMENTS: Shallow waters with abundant aquatic vegetation.

NESTING: Egg dates: March 25 to June 15. Peak: May, Atlantic coast (Palmer 1976 V. 2:45). Clutch size: 2 to 11, typically 5 to 7. Incubation period: 35 to 36 days. Nestling period: 1 day (precocial). Broods per year: 1. Age at sexual maturity: 2 to 6. Nest site: Nest on the ground, preferably on small islands along secluded shores, in marshes, or at ponds. Favors shallow, clean, weed-filled waters. Sometimes colonial. Nest is typically placed in a clump of cattails surrounded by water.

TERRITORY SIZE: 4 to 10 acres (1.6 to 4.0 ha) in Michigan (Wood and Gelston 1972). 12 territories ranged from 0.2 to 11.8 acres (0.2 to 4.8 ha) in Rhode Island (Willey 1976 in Palmer 1976 V. 2:44). When a pond is chosen for nesting, a male defends the entire pond against intruders (Palmer 1976 V. 2:44).

SAMPLE DENSITIES: Many scores of semi-domestic pairs nested on 25 acres (10.1 ha) in England indicating that these birds will usually tolerate closer nesting (Palmer 1958 in Palmer 1976 V. 2:44).

FORAGING: Major foods: Fish, crustaceans and aquatic insects (adults and larvae). Substrates: Water, bottom of shallow bodies of water. Techniques: Immersing head and neck, up-ending in dabbling-duck fashion. Preferred feeding habitat: Areas with abundant submerged vegetation.

COMMENTS: Pair bond—life-long monogamy. Diet consists of nearly 100 percent vegetable material. Willey (1968 in Palmer 1976 V. 2:46) found by experiment that a swan consumed 8.4 pounds of wet vegetation per acre over a 7-day period.

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Palmer 1976 V. 2.

Canada Goose

(*Branta canadensis*)

O.U. No. 172.0



Range

Permanent



GE: Breeding: Coastal regions from Labrador to North Carolina. Scattered populations in inland refuges. Winter: Coast of Newfoundland s. to n. Mexico. Probably as much as 75 percent of the population winters from New Jersey to North Carolina (Palmer 1976 V. 2:192).

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Massachusetts) to uncommon (Maine) in breeding season. Common (Maine) in winter.

HABITAT: Breeding: Coastal salt marshes, shores of ponds and lakes, grassy fields. Wintering: Ice-free ponds, rivers, ponds, and coastal marshes that provide resting and feeding sites and agricultural lands that provide additional grazing areas.

SPECIAL HABITAT REQUIREMENTS: Shallow water, abundant plant foods.

REPRODUCTION: Egg dates: March 28 to May 14, New York (Bill 1974:99). Clutch size: 4 to 10, typically 5 or 6. Incubation period: 28 days. Nestling period: 1 day (precocial). Age at first flight: More than 50 days. Broods per year: 1. Age at sexual maturity: 2 or 3 years. Nest site: Typically near water in a grass-lined depression on ground. Occasionally in tree on abandoned nest of Osprey.

TERRITORY SIZE: Varies considerably. Size seems to be influenced by aggressiveness of defending male, type of habitat, amount of protective cover and density of breeding population (Bellrose 1976:159).

SAMPLE DENSITIES: Breeding densities vary greatly and seem to be influenced by availability of suitable nest sites rather than by territorial behavior (Johnsgard 1975:142).

FORAGING: Major foods: Tender shoots of grasses, sedges and other marsh plants, submerged vegetation, cultivated grains, and wild seeds and fruits. Substrates: Wet and dry ground water. Techniques: Ground gleaning, grazing, immersing head and neck. Preferred feeding habitat: Mud flats, grain fields, salt marshes, shallow waters of bays.

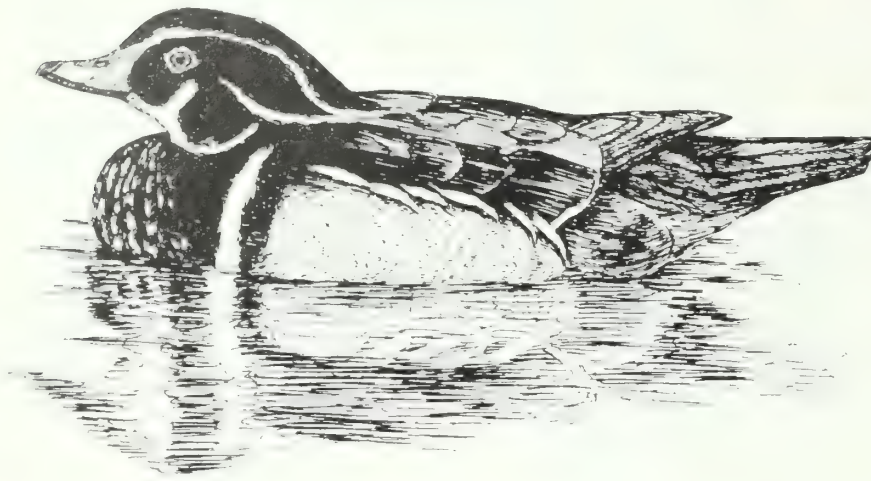
COMMENTS: Pair bond—life-long monogamy. Diet consists almost entirely of vegetable material.

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Palmer 1976 V. 2.


Wood Duck

(*Aix sponsa*)

A.O.U. No. 144.0



Range

 Breeding



RANGE: Breeding: Northern Nova Scotia, s. to the s. tip of Florida, w. to the midwestern states. Winter: Maryland s. to Florida, w. to e. Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon in breeding season, rare in winter.

HABITAT: Breeding: Shallow waters of ponds, lakes, or marshes having abundant floating and emergent vegetation. Wooded swamps or open flooded lowland forests where food is available. Shuns salt water. Wintering: Few birds winter in New England.

SPECIAL HABITAT REQUIREMENTS: Trees at least 16 inches d.b.h. with large cavities for nesting (minimum entrance hole 4 inches in diameter) (Scott et al. 1977, McGilvrey 1968).

NESTING: Egg dates: March 28 to July 15, New York (Bull 1974:108). Clutch size: 6 to 15, typically 9 to 14. Incubation period: 28 to 37 days, average 30 days. Nestling period: 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 65 feet, (0.6 to 19.5 m). Typically 20 to 50 feet (6.1 to 15.2 m). Nest site: In cavity of living (occasionally dead) deciduous or coniferous tree, usually within several hundred yards of water. Prefers water with brushy overstory for concealment and stumps and fallen logs for perching. Accepts nest boxes but usually occupies natural cavities and those excavated by Pileated Woodpeckers.

TERRITORY SIZE: Wood Ducks apparently do not defend an area around the nest. Drakes prevent other males

from approaching mates for a short period prior to laying (Grice and Rogers 1965:20).

HOME RANGE: No size information. Range seems unstable with dimensions and boundaries changing during the nesting season (Bellrose 1976:186).

SAMPLE DENSITIES: 63 nests (nest boxes) per 150 acres (60.7 ha) in open marsh in Massachusetts (Grice and Rogers 1965:20). 1 nest per 12 acres (4.9 ha) (Bellrose et al. 1964).

FORAGING: Major foods: Aquatic and terrestrial insects, acorns (favorite food), hickory nuts, waste grain seeds of aquatic plants, fleshy fruits. Substrates: Shallow water, forest floor, fields. Techniques: Grazing, immersing head and neck, up-ending. Preferred feeding habitat: Water less than 18 inches deep that is still or slowly flowing (Johnsgard 1975:173).

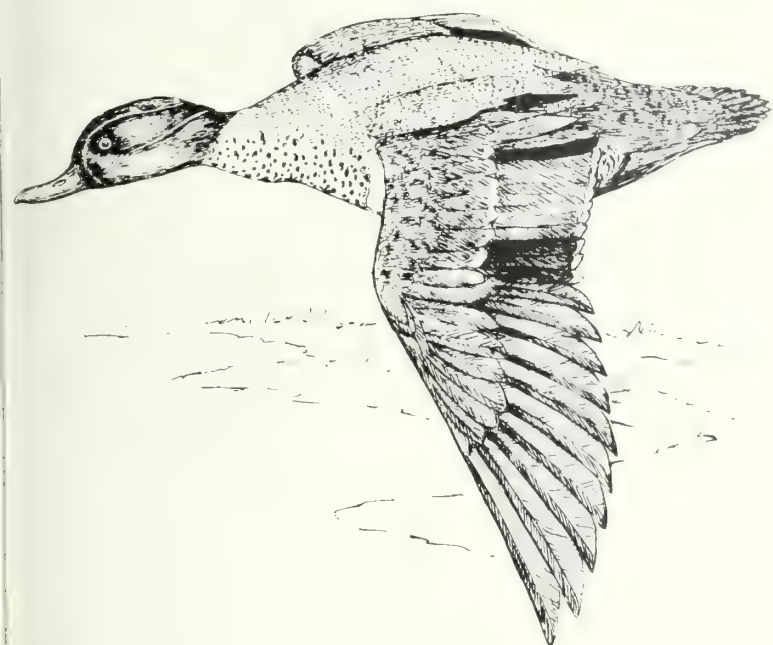
COMMENTS: Draining and clearing of lowlands degrades breeding and wintering Wood Duck habitat. Wood Ducks in Ontario find good breeding habitat in wetlands with beaver ponds and cavities made by Pileated Woodpeckers. Diets of Maine birds consisted of 95 percent vegetable and 5 percent animal material (Coulter 1957).

KEY REFERENCES: Bellrose 1976, Coulter 1957, Grice and Rogers 1965, Hester and Dermid 1973, Palmer 1973, V. 3.

Green-winged Teal

(*Anas crecca*)

D.U. No. 139.0



Range



AGE: Breeding: Labrador, w. to n. Alaska, s. to the mountains of n. New England, s. Colorado and California. Occasionally breeds at inland ponds in Massachusetts, New Jersey, Maryland, and Pennsylvania. Winter: Northern New England w. to s. Alaska, s. In the Atlantic Bay, most birds winter between New Jersey and Florida. Small numbers winter n. to s. Canada.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and local (Mont) to common (Maine) breeder. Uncommon in winter.

HABITAT: Breeding: Ponds, lakes, sedge meadows, marshes near grasslands, dry hillsides with bushy thickets or adjacent open woodlands. Generally an upland bird. Wintering: Tidal creeks and ponds bordered by mudflats, estuaries, coastal brackish marshes. Avoids open salt water.

REPRODUCTION: Egg dates: May 25 to July 15, New York (Bull 1972:123). Clutch size: 5 to 16, typically 10 to 12. Incubation period: 21 to 23 days. Nestling period: Less than 1 month (precocial). Age at sexual maturity: 1 year. Broods per year: 1. Nest site: Prefers dense stands of grass, sedges, brush, 2 to 300 feet (0.6 to 91.4 m) from water (average 95 feet, 29 m) (Bellrose 1976:223). Nests are so well hidden they are difficult to find.

POPULATION DENSITIES: 1 pair per 60 acres (24.3 ha) in grasslands in Alberta (Keith 1961). 20 pairs per square mile (8 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FORAGING: Major foods: Seeds (staple) of wetland plants especially millets, smartweed, and nutgrasses; insects, crustaceans, mollusks. Substrates: Shallow water, mud. Techniques: Dabbling, grazing, gleaning. Preferred feeding habitat: Prefers mudflats. Also forages in flooded or dry grain fields and woodlands.

COMMENTS: Birds do not commonly nest in the Northeast. Occasionally they raise broods at inland ponds and marshes and along coast in the New Jersey-Long Island area. They are uncommon in winter but may appear in large groups locally. Occasionally they are seen in company of Eurasian Green-winged Teal (*A. c. crecca*).

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Palmer 1976 V.2.

American Black Duck

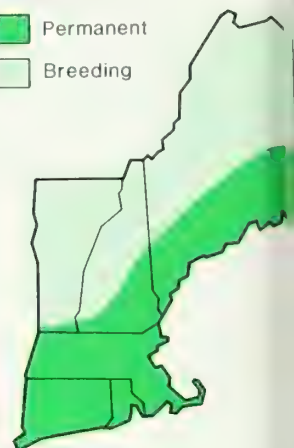
(*Anas rubripes*)

A.O.U. No. 133.0



Range

- Permanent
- Breeding



RANGE: Breeding: Quebec and Labrador s. to Cape Hatteras, North Carolina. Greatest densities occur in coastal marshes. Winter: East coast—from Canadian border s. to Florida with about two-thirds remaining between Long Island and North Carolina. Inland—Lake Erie marshes and large river valleys.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant to uncommon.

HABITAT: Breeding: Marshy borders of ponds, lakes, rivers, and streams, wooded swamps, fresh, salt and brackish marshes and meadows. Wintering: Extensive open marshes of coast and interior. Blacks commonly return to same wintering areas year after year.

NESTING: Egg dates: April 2 to June 22, New York (Bull 1974:112). Clutch size: 6 to 11, typically 8 to 10. Incubation period: 26 to 28 days. Nestling period: Less than 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Usually on ground. Most nests are well hidden in vegetation (grasses, shrubs, briers, etc.) and are close to water. In uplands, nests may be a mile or more from water (Palmer 1976 V.2:329). Occasionally uses old crows and hawks nests, natural or excavated (pileated woodpecker) cavities in trees or tops of rotted stumps.

TERRITORY SIZE: 6 acres (2.4 ha) in Lake Erie marsh (Trautman 1947 in Palmer 1976 V. 2:338).

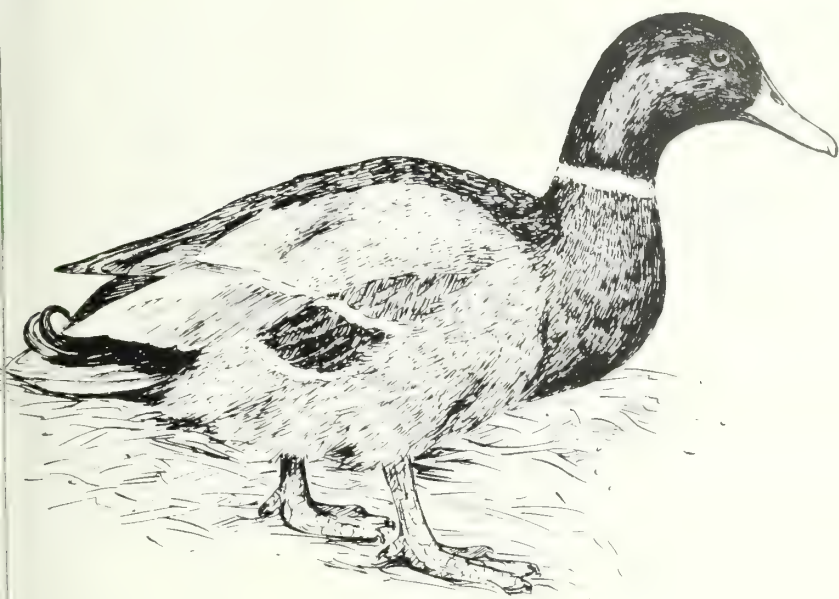
HOME RANGE: Up to 5 square miles (13 km²) in New England (Coulter and Miller 1968).

SAMPLE DENSITIES: 1 nest per 20 to 40 acres (8.1 to 16.1 ha) in bogs in Maine (Coulter and Miller 1968). 0.4 nests per acre (0.4 ha) on islands in Chesapeake Bay (Stotts 1957). 5 nests per acre (0.4 ha) on islands in Lake Champlain (Coulter and Miller 1968). 5.3 pairs per hundred acres (40 ha) of brackish marsh in Maryland (Coulter 1962).

FORAGING: Major foods: Mollusks (coastal staple), submerged aquatic plants, waste grains, acorns, seed marsh plants, crustaceans, earthworms, amphibians, and fishes. Substrates: Shallow water, grain fields. Techniques: Dabbling, grazing, gleaning.

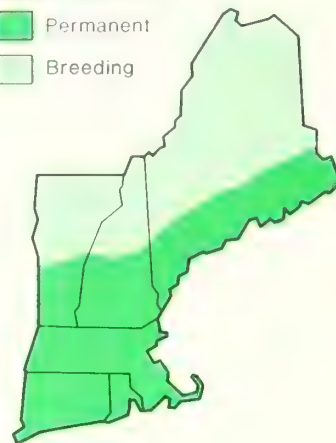
COMMENTS: Foods vary widely in different habitats. Plants comprise most of diet in fresh and brackish areas and animals are principal foods in marine environments. In late fall and winter, birds may leave their rest areas in the day and just before sunset to travel to waste fields up to 25 miles (40 km) away (Bellrose 1976:253). Interbreeds with mallards—3 percent of blacks in Atlantic flyway show plumage feathers of both species (Bellrose 1976:253).

KEY REFERENCES: Bellrose 1976, Coulter and Miller 1968, Palmer 1962, Stotts 1957.



Range

-  Permanent
-  Breeding



RANGE: Breeding: Very broad breeding range covering the n. half of the United States, s. to n. Virginia in the East and Kansas and n. New Mexico in the West. Winter: East from Nova Scotia inland from Maryland w. to c. Alaska and s. to s. Mexico. Feral stock in Massachusetts through winter.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common: (Massachusetts) to uncommon (Maine).

HABITAT: Breeding: Ponds, lakes, rivers, streams, marshes, wet meadows, wooded swamps. Prefers water less than 16 inches (41 cm) deep (Pough 1951:77). Avoids salt water. Wintering: Coastal marshes, inland tree ponds and rivers.

SPECIAL HABITAT REQUIREMENTS: Shallow water (less than 16 inches (41 cm) deep) that enables duck to bottom feed by tipping up (Pough 1951:77).

REPRODUCTION: Egg dates: March 25 to July 1, New York (Bull 194:110). Clutch size: 6 to 15, typically 7 to 10. Incubation period: 26 to 30 days. Nestling period: Less than 1 month (precocial). Broods per year: 1. Age at sexual maturity: 1 year (some individuals breed later). Nest site: Nest usually located within 100 yards of water (Bellrose 1966:237) typically near water's edge in places where ground is dry or slightly marshy and vegetation is plentiful. Rarely nests in cavities, on hollowed tops of stubs or in tree crotches.

TERRITORY SIZE: About 2 square miles (5.2 km²) at onset of breeding season (Palmer 1976 V.2:298). Territory co-

incides with home range early in breeding season and becomes progressively smaller as season advances. Drake probably defends mate rather than land area (Dzubin 1969 in Palmer 1976, V. 2:298).

HOME RANGE: About 2 square miles (5.2 km²) at onset of breeding season (Palmer 1976 V.2:298). 700 acres (283.4 ha) in Manitoba (Dzubin 1955).

SAMPLE DENSITIES: 93 pairs per square mile (36 pairs/km²) in Canadian Parklands (Dzubin 1969 in Palmer 1976, V. 2:300). 6.1 pairs per square mile (2 pairs/km²) in prairie pothole habitat (Drewien and Springer 1969). 29 nests per 5.7-acre (2.3-ha) island in Lake Champlain (Coulter and Miller 1968).

FORAGING: Major foods: Seeds of sedges, grasses and smartweed are staples; also eats leaves, stems and seeds of other marsh plants, waste grain, snails, insects. Substrates: Shallow water, grain fields, meadows, bottoms of bodies of water. Techniques: Dabbling, grazing, gleaning.

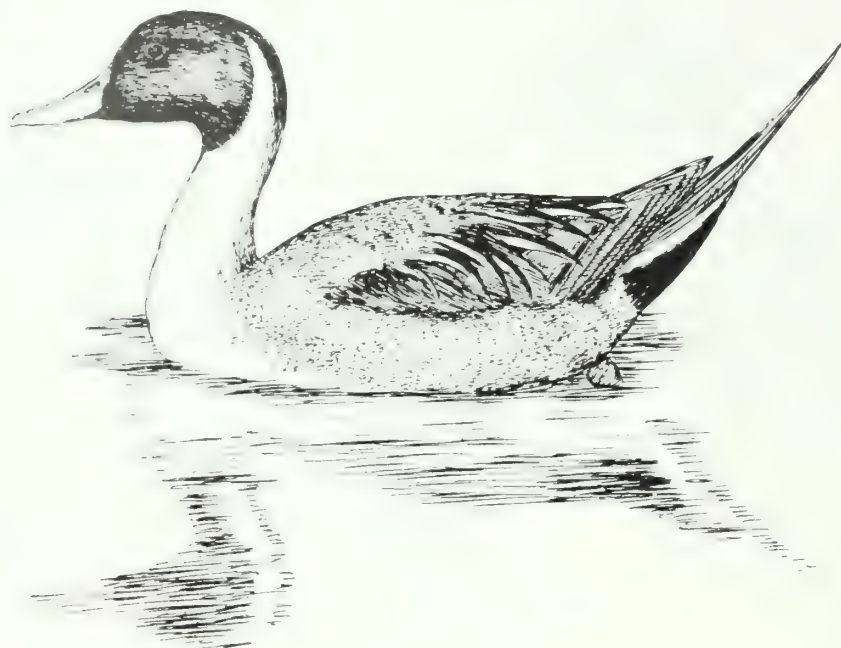
COMMENTS: About 40,000 Mallards winter between Massachusetts and Chesapeake Bay. Another 40,000 winter in the Chesapeake Bay itself (Bellrose 1976:235). It is presently the most abundant duck in North America but is not common throughout the Northeast.

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Palmer 1976 V. 2.

Northern Pintail

(*Anas acuta*)

A.O.U. No. 143.0



Range



RANGE: Breeding: Hudson Bay w. to n. Mackenzie, s. to w. Iowa, n. New Mexico and s. California. Scattered breeding in Massachusetts (Monomoy). Winter: Atlantic coast—coastal Massachusetts and s. New England (occasionally) and mainly New Jersey s. to Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare breeder, locally common in winter.

HABITAT: Breeding: Shallow freshwater areas such as marshes, swamps and ponds generally in open country with low vegetation. Wintering: Fresh, brackish, and salt water marshes; large numbers occur in the Chesapeake Bay area and southward.

SPECIAL HABITAT REQUIREMENTS: Drakes need mudbanks or exposed water margins (Palmer 1976 V. 2:446).

NESTING: Egg dates: April to July (Bellrose 1976). Clutch size: 3 to 14, typically 7 to 9. Incubation period: 21 to 22 days. Nestling period: Less than 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Often in a hollow on dry ground; may or may not be concealed by grasses or shrubs, usually within 100 yards (average 40 yards) from water (Bellrose 1976:271).

TERRITORY SIZE: Pintails have shown little evidence of territoriality (Johnsgard 1975).

SAMPLE DENSITIES: 5.6 pairs per square mile (2 pairs per km²) in South Dakota (Drewien and Springer 1969).

About 12 pairs per 100 acres (40 ha) of water in Alb. (Keith 1961). 32 pairs per square mile (12 pairs per km²) in favorable habitat in North Dakota (Stewart and Kuntz 1972).

FORAGING: Major foods: The Pintail is chiefly a seed eater, preferring seeds of pondweeds, sedges, grasses, smartweeds and cultivated grains. Substrates: Shallow water, marsh vegetation. Techniques: Dabbling, grazing. Preferred feeding habitat: Shallow waters of marshes, ponds, meadows, and grain fields.

COMMENTS: On wintering grounds, Pintails feed in fields on mast or grain or on tidal flats where they pick up marine animals (Pough 1951:82). Anderson (1959) and Palmer 1976 V. 2:458 found that the contents of 881 Pintails taken in Illinois consisted of 97 percent vegetable matter and 3 percent animal matter.

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Munro 1944, Palmer 1976 V. 2.

Blue-winged Teal

(*as discors*)

D.U. No. 140.0



Range

 Breeding



RANGE: Breeding: New Brunswick, s. to Tennessee and North Carolina, w. to s. Yukon and California. Winter: Northern Maryland, s. to Florida, w. to Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common in breeding season. Rare in winter.

HABITAT: Breeding: Fresh water coastal marshes, fresh water ponds, rivers, ponds, and lakes. Prefers shorelines to open water and prefers calm water or sluggish currents in open water. Rarely uses salt or brackish areas (Bull 1976:126). In New York, birds favor large freshwater ponds and ponds with emergent vegetation (Bull 1976:126). Wintering: Shallow inland fresh water ponds, coastal brackish and salt water marshes.

REPRODUCTION: Egg dates: May 3 to July 4, New York (Bull 1976:126). Clutch size: 6 to 15, typically 8 to 11. Incubation period: About 24 days. Nestling period: Less than 1 month (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Prefers dense grassy sites, such as tall grass, hayfields, or sedge meadows, or ground uncovered within a mile of water's edge. Occasionally nests on a sedge tussock or muskrat house surrounded by water.

TERRITORY SIZE: Male appears to defend the female rather than an area of land (Johnsgard 1975:278, Bellrose 1976:281).

POPULATION RANGE: 250 acres (101.2 ha) in Manitoba (Dzubin 1975). 1.4 to 78.6 acres (0.6 to 31.8 ha) (average 17 acres (6.9 ha)) in Manitoba (McHenry 1971 in Bellrose

1976:281). 89 acres (36 ha) in South Dakota (Evans and Black 1956).

SAMPLE DENSITIES: 18 pairs per 100 acres (40, ha) on impoundments in Alberta (Keith 1961). 17.4 to 63.6 pairs per 100 acres (40, ha) on a variety of ponds in South Dakota (Drewien and Springer 1969). 4 to 22 pairs per 100 acres (40, ha) of wetland at 4 wetlands in Wisconsin (Jahn and Hunt 1964).

FORAGING: Major foods: Seeds of sedges, grasses, pondweeds, and smartweeds (staple foods); also eats leaves of aquatic plants, snails, crustaceans, and insects. Substrates: Water, mud, short grasses. Techniques: Dabbling, grazing, gleaning. Preferred feeding habitat: Mud flats, shallow water, fields.

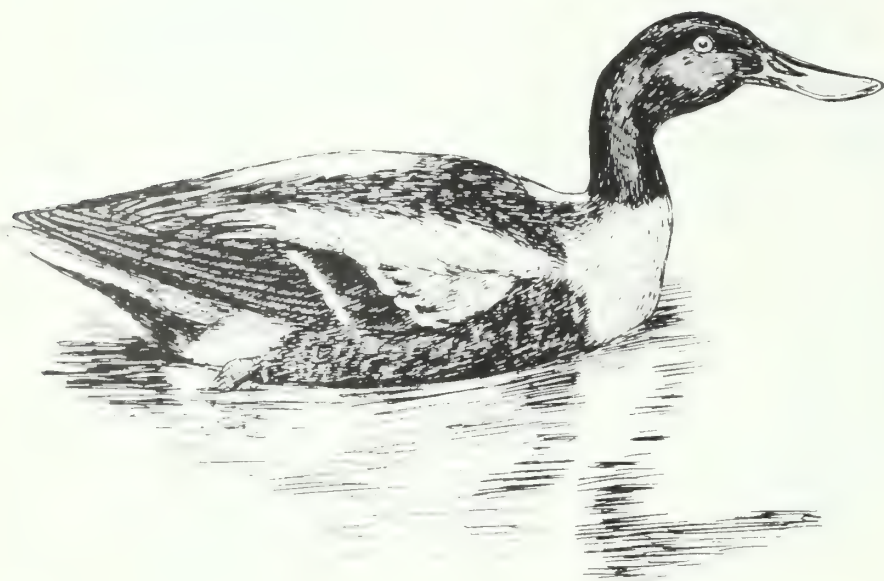
COMMENTS: Mabbott (1920 in Palmer 1976 V. 2:481) found that 70 percent of the diet is vegetable and 30 percent is animal. Blue-winged Teal are often seen feeding with green-winged Teal, but they have different food habits. Blue-winged Teal eat fewer seeds and more of the vegetative (leaves and stems) parts and more animal matter than do Green-winged Teal.

KEY REFERENCES: Bellrose 1976, Bennett 1938, Johnsgard 1975, Palmer 1976 V.2.

Northern Shoveler

(*Anas clypeata*)

A.O.U. No. 142.0



Range



RANGE: Breedings: Hudson Bay w. to w. Alaska, s. to n. Illinois, Oklahoma and s. California. Breeds very locally and irregularly in the Northeast, Lake Erie marshes in Ohio, Montezuma Marsh in New York. Winter: Long Island, New York w. to s. British Columbia, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and local breeder, rare in winter.

HABITAT: Breeding: Sloughs, marshes, shallow ponds with open water and abundant aquatic vegetation. Apparently tolerates water pollution or stagnation. Wintering: Coastal bays and marshes, tidal flats.

SPECIAL HABITAT REQUIREMENTS: Shallow bodies of water with muddy bottoms, surrounded by dry grassy areas for nesting.

NESTING: Egg dates: Early April to early May, Delaware (Palmer 1976 V. 2:512). Clutch size: 8 to 13, typically 9 to 11. Incubation period: 22 to 24 days. Nestling period: Less than 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Prefers to nest in short grasses on dry ground. If unavailable, birds will use hayfields and meadows. Seldom nests in weedy patches and avoids woody vegetation such as willows. Nests are usually 75 to 200 feet (23 to 61 m) from waiting areas (Bellrose 1976:297). Shallow prairie marshes are preferred habitats (Johnsgard 1975:292).

TERRITORY SIZE: Males may defend mates rather than area of land (Hori 1963).

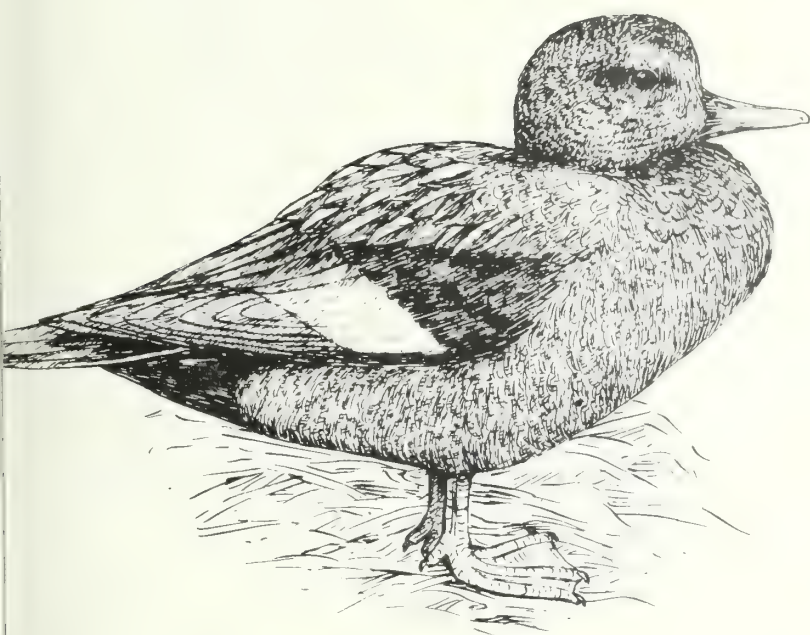
HOME RANGE: 8 home ranges ranged from 20 to 200 acres (8.1 to 51.8 ha) (average 76 acres, (30.8 ha)) (Poston 1969). 6 home ranges ranged from 15 to 90 acres (6.1 to 36.4 ha) average 49.7 acres (20.1 ha) (Poston 1969).

SAMPLE DENSITIES: 4.5 birds per square mile (2 pairs/km²) in mixed prairie habitat (Bellrose 1976:293). 1 pair per square mile (5 pairs/km²) on a 3-square-mile (7.8 km²) study area (Poston 1969). 44 pairs per square mile (17 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FORAGING: Major foods: Aquatic insects, snails, fish, crustaceans, seeds of aquatic plants, plankton. Strategies: Shallow water (surface and bottom), deep water (surface). Techniques: Immersing neck (rarely upending).

COMMENTS: Shovelers strain water through the lamellae of mandibles in order to separate and consume plankton.

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Palmer 1976 V.2, Poston 1969.



Range



AGE: Breeding: Main breeding range is in the West. The 1939 gadwalls have been increasing in the East but breeding colonies are scattered. Lake Erie marshes in Ohio, Montezuma Marsh, New York, and a marsh near Concord, Massachusetts, are locations of a few eastern colonies. Winter: Coastal areas New York to Florida. Largest numbers occur from Chesapeake Bay, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Massachusetts) to rare (Maine).

HABITAT: Breeding: Mainly on fresh water impoundments created on the brackish marshes of coastal national wildlife refuges and state management areas. Also found on shallow to deep, open-water marshes. Winter: Coastal bays and marshes that remain free of ice; occasionally ice-free, wooded lakes.

SPECIAL HABITAT REQUIREMENTS: Moderate to large bodies of water. Submerged aquatic plants for food.

REPRODUCTION: Egg dates: May 30 to July 25, New York (Bull 1971:114). Clutch size: 5 to 13, typically 8 to 11. Incubation period: 24 to 27 days. Nestling period: 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year (at-hatched young may breed the second year). Nest site: Tends to be colonial nester. Prefers small islands and dikes in marshes, fields, and meadows usually within a few feet from water. Prefers uplands to nesting over water and uses dense vegetation (especially bulrush *Scirpus*) and willow (*Salix*) for cover (Williams and Marshall 1938).

HOME RANGE: Ranged from 34 to 87 acres (13.8 to 35.2 ha) (average 67 acres—27.1 ha) at Ogden Bay Marsh, Utah (Gates 1962).

SAMPLE DENSITIES: This is primarily a prairie pothole resident. Sample densities are: average 6.3 birds per square mile (2 pairs/km²) in mixed prairies of North Dakota (Bellrose 1976:209). 200 nests per acre (0.4 ha) (island) Lower Souris National Wildlife Refuge, North Dakota (Henry 1948 in Palmer 1976 V. 2:394). 1 pair per 60 to 80 acres (24.3 to 32.4 ha) in pothole areas of Dakotas (Palmer 1976 V. 2:394). New England densities are unknown, but would not approach these concentrations.

FORAGING: Major foods: Submerged aquatic plants (seeds or soft parts)—pondweeds, naiads, widgeon grass, eelgrass, filamentous algae, etc. Substrates: Shallow water. Techniques: Dabbling, diving.

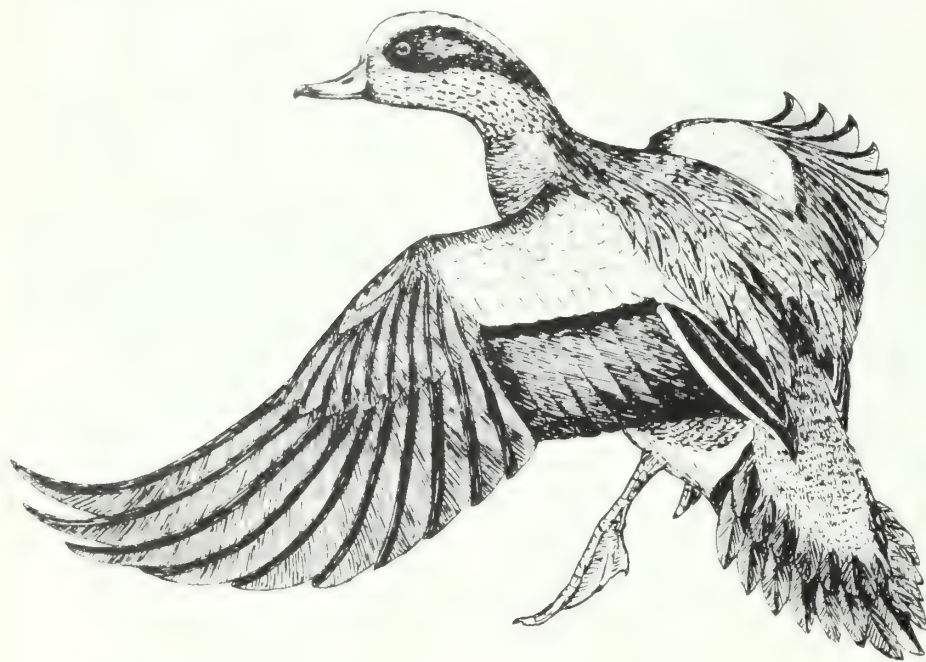
COMMENTS: Mabbott (1920 in Palmer 1976 V. 2:400) found that 98 percent of the contents of 362 stomachs was vegetable and 2 percent animal matter. Gadwalls prefer succulent stems to seeds. They rarely graze in pastures or grain fields.

KEY REFERENCES: Bellrose 1976, Gates 1962, Palmer 1976 V. 2.

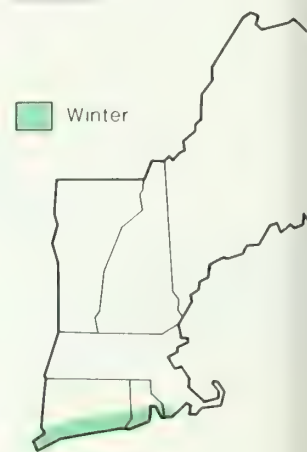
American Wigeon

(*Anas americana*)

A.O.U. No. 137.0



Range



RANGE: Breeding: Hudson Bay, w. to Alaska, s. to w. Pennsylvania and Nebraska. Scattered breeding has occurred in New York, Delaware, Massachusetts, and w. Pennsylvania. Winter: Southern New England, Ohio Valley, se. Alaska, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and local breeder. Range is spreading eastward. Common along coast in winter.

HABITAT: Breeding: Isolated breeder. Perhaps large lakes or marshes with abundant open, shallow water and emergent vegetation especially sedges (*Carex* spp.) and rushes (*Juncus* spp.). Wintering: Shallow fresh and brackish ponds, wet meadows, coastal marshes, and bays.

NESTING: Clutch size: 3 to 11, typically 8 or 9. Incubation period: 22 to 24 days. Nestling period: Less than 1 day (Precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Nest may be close to water on an island or shore or as far as 400 yards (366 m) from water in open grassland or woodland. Usually on dry ground (Bellrose 1976:203).

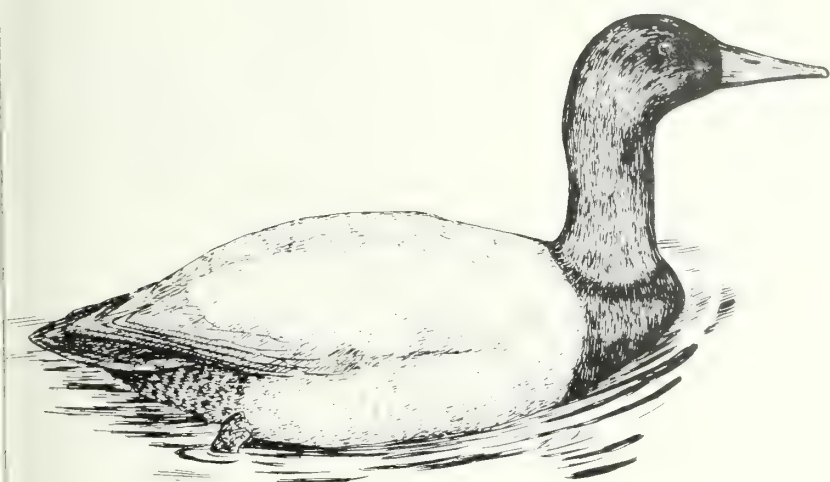
SAMPLE DENSITIES: 16.6 birds per square mile (6 birds/km²) at Mackenzie River Delta (Bellrose 1976:199). 9.4 birds per square mile (4 birds/km²) at Yukon Flats in Alaska (Bellrose 1976:199). 7.4 birds per square mile (3 birds/km²) in parklands (Bellrose 1976:199). 1.66 birds per square mile (0.6 birds/km²) in closed boreal zone of Ontario (Bellrose 1976).

FORAGING: Major foods: Almost wholly vegetarian ing quantities of leaves, stems, and buds on pondwe widgeon grass (staples), and wild celery, also eats ten shoots of grasses and occasionally snails. Substra Shallow water. Techniques: Dabbling, grazing, bot and plant gleaning. Preferred feeding habitat: La open water areas with abundant submerged plants.

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Mu 1949, Palmer 1976 V. 2.

Canvasback
(*Aythya valisineria*)

O.U. No. 147.0



Range



RANGE: Breeding: Southern Wisconsin nw. to Macken-
delta and c. Alaska, s. to New Mexico and Nebraska.
Winter: Southern New England and e. New York, s.
along the coast to Florida and w. through the Gulf States.
Greatest numbers winter from New York to the Ches-
apeake Bay.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon and
local in winter.

HABITAT: Wintering: Coastal areas, with greatest con-
centrations occurring in the Chesapeake Bay area. Pre-
fers fresh and brackish estuarine bays with submerged
plants, especially wild celery and eelgrass.

SPECIAL HABITAT REQUIREMENTS: Water areas with emer-
gent vegetation. Stretches of open water for taking off
and landing.

FEEDING: Major foods: Seeds and vegetative parts of
aquatic plants, especially wild celery (*Vallisneria* spp.)
and pondweeds (*Potamogeton* spp.), aquatic inverte-
brates. Substrates: Water. Techniques: Diving. Prefer-
ed feeding habitat: Large, permanent bodies of water.

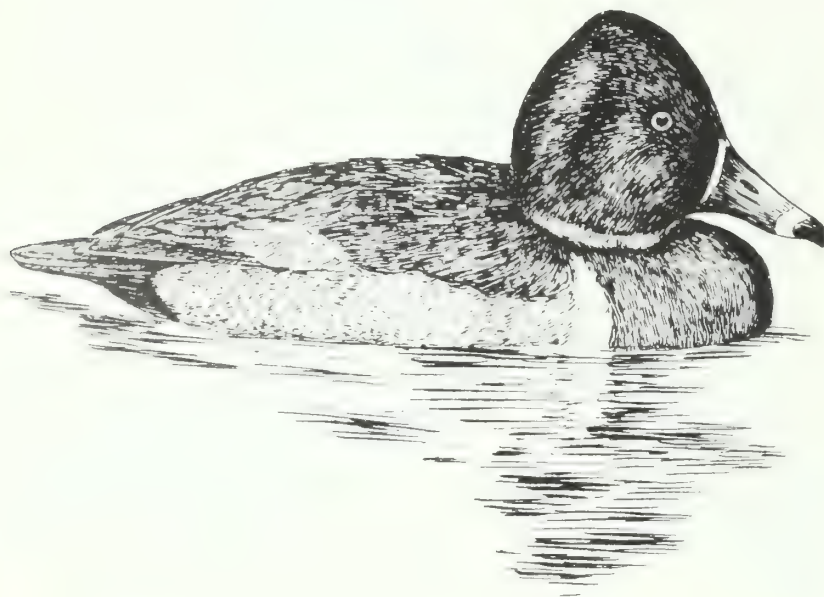
COMMENTS: Winter surveys in the United States have
shown a decline in Canvasbacks over the past 20 years.

REFERENCES: Bellrose 1976, Hochbaum 1944,
Longsgard 1975.



Ring-necked Duck

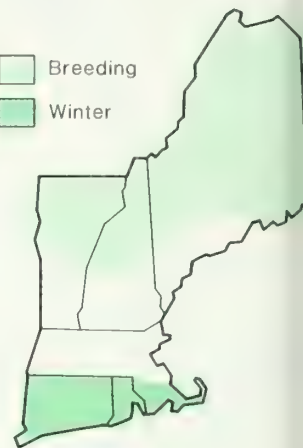
Aythya collaris

A.O.U. No. 150.0



Range

-  Breeding
-  Winter



RANGE: Breeding: Interior Newfoundland s. to n. New England and New York State (Adirondacks). Has nested in Massachusetts sporadically and rarely. Winter: Southern New England s. to Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to rare (Massachusetts).

HABITAT: Breeding: Flooded swamps, fresh water marshes, and bogs with abundant sedge, sloughs and beaver flowages near larger wooded lakes or rivers with submerged and emergent vegetation, often in heavily forested areas. Wintering: Fresh or brackish marshes and rivers. Seldom uses strictly saline water.

SPECIAL HABITAT REQUIREMENTS: Needs an expanse of open water to become airborne.

NESTING: Egg dates: Mid-May to early July. Peak: Mid-May (Maine) (Mendall 1958). Clutch size: 5 to 14, typically 9. Incubation period: 25 to 29 days. Nestling period: 1 day (precocial). Age at first flight: 49 to 56 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: In Maine, nests are typically on a floating mat of vegetation, but often in clumps of herbaceous or shrubby growth or on islands. Common cover plants are sedges, sweet gale, and leather leaf. Most nests are within a few feet of open areas with water (Bellrose 1976:332).

TERRITORY SIZE: Pairs space themselves but show little aggression. In Maine, Mendall (1958) observed ducks nesting as closely as 5 or 6 feet (1.5 to 1.8 m).

SAMPLE DENSITIES: 1 pair per 6 acres (2.4 ha) to 1 pair per 23 acres (9.3 ha) in various habitats (Mendall 1958:65). nests were found on a 1/4-acre (0.1 ha) island in Maine (Mendall 1958). Average (6 years) 9 pairs per 100 acres (40 ha) in northern Wisconsin wetlands (Jahn and Hu 1964).

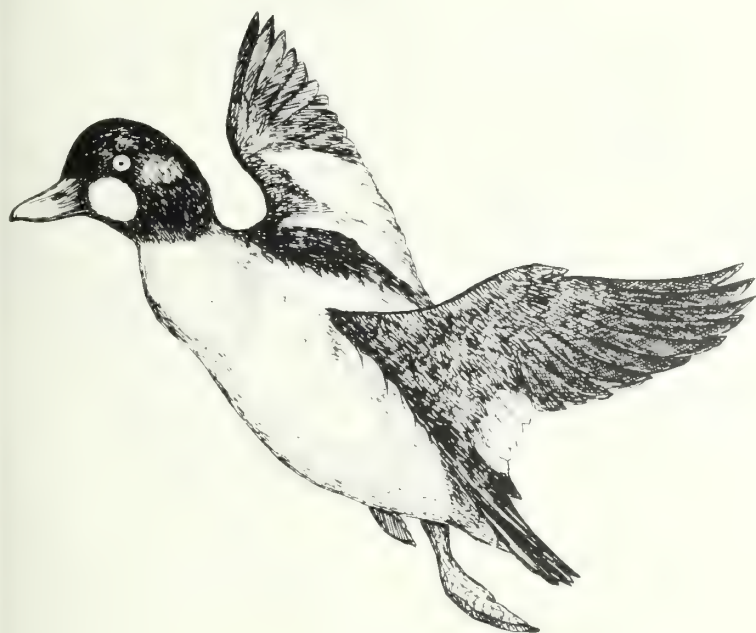
FORAGING: Major foods: Seeds and vegetative parts of submergent and emergent plants — 75 percent of diet; insects, mollusks, and so on — 25 percent of diet (Bellrose 1976:334). Substrates: Water, sandy and muddy bottoms. Techniques: Diving. Preferred feeding habitat: Shallow water, usually less than 6 feet deep (Bellrose 1976:334).

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Mendall 1958, Palmer 1976 V. 3.

Common Goldeneye

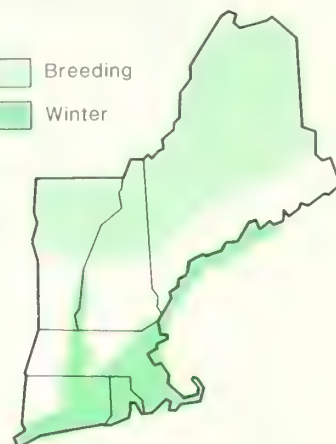
(*Bucephala clangula*)

O.U. No. 151.0



Range

 Breeding
 Winter



RANGE: Breeding: Northern New England and New York, w. to n. Michigan and Minnesota and n. throughout much of Canada. Winter: Newfoundland to Florida. Most wintering birds are located on the coast between Long Island and North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon in the breeding season but common along coast in winter.

HABITAT: Breeding: Ponds, lakes, shallow rivers, floodplain forests and bogs, slowly flowing streams with wet, muddy margins, usually near or in open wooded areas with large cavity-bearing trees. Wintering: Atlantic coast — on brackish or salt water estuarine bays. Inland — a few winter on large rivers.

SPECIAL HABITAT REQUIREMENTS: Large trees, minimum db.h. 20 inches (Thomas et al. 1979) with cavities for nesting and clear, cold, shallow water for feeding.

REPRODUCTION: Egg dates: April 7 to May 25, New Brunswick (Carter 1958). Clutch size: 5 to 15, typically 7 to 10. Incubation period: About 30 days. Nestling period: 1 to 2 days (precocial). Broods per year: 1. Age at sexual maturity: 2 years. Nest height: 6 to 60 feet (1.8 to 18.3 m), typically 20 feet (6.1 m). Nest sites: Cavities in trees in forested areas (often in silver maple or American elm in the Northeast). Open bucket-type cavities are commonly used and in New Brunswick proved better nest sites than enclosed cavities (Prince 1968). Also occupies cavity made by other species or uses natural cavities. Occasionally birds use terrestrial cavities among rocks. Accept nest boxes.

TERRITORY SIZE: No size information. The male defends a small area surrounding the nest site.

SAMPLE DENSITIES: Approximately 1 pair per 100 acres (40 ha) of hardwood swamp in New Brunswick (Carter 1958).

FORAGING: Major foods: Crustaceans; larvae of aquatic insects; mollusks; seeds, fruits, roots, and stems of aquatic plants. Substrates: Clear water, hard sandy bottoms. Techniques: Diving, drift-feeding (in currents), overturning stones on bottom with bill. Preferred feeding habitat: Shallow water 3 to 12 feet (0.9 to 3.7 m) deep (less than 5 feet (1.5 m) preferred).

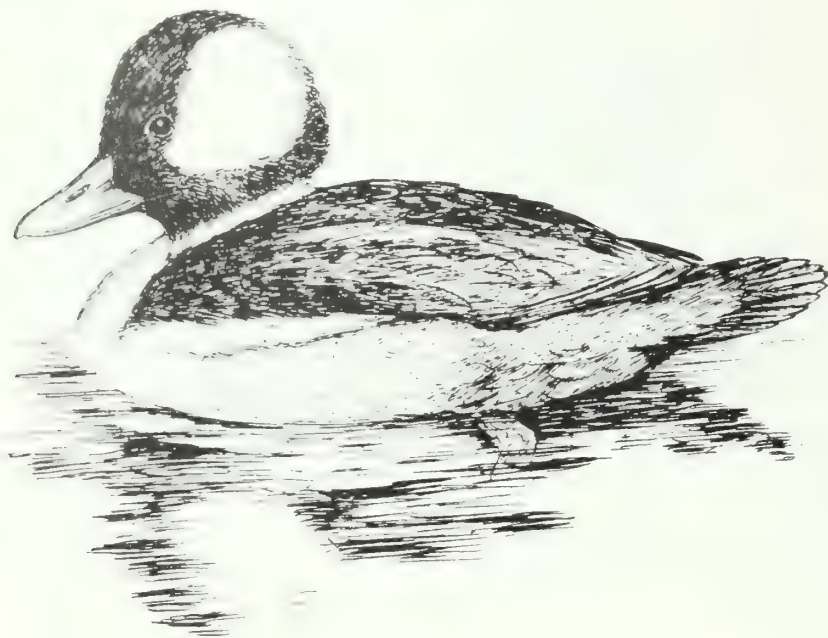
COMMENTS: 16 cavities in New Brunswick were located at an average height of 23 feet (7.0 m) above the ground in trees that averaged 26 inches (66 cm) in diameter. The trees were about 60 years old (Prince 1968). Cottam (1939 in Palmer 1976 V. 3:397) found that the contents of 395 stomachs contained 74 percent animal and 26 percent vegetable matter.

KEY REFERENCES: Bellrose 1976, Carter 1958, Palmer 1976 V. 3, Prince 1968.

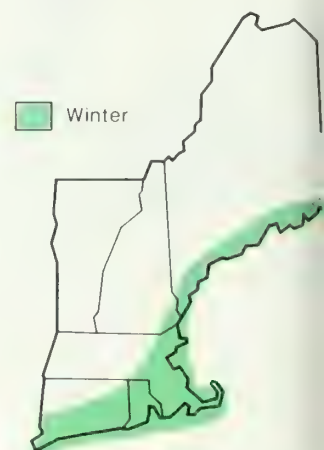
Bufflehead

(*Bucephala albeola*)

A.O.U. No. 153.0



Range



RANGE: Breeding: James Bay, w. and n. Winter: Atlantic Coast from s. Newfoundland to s. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in winter.

HABITAT: Wintering: Offshore and in sheltered salt and brackish waters of harbors and bays, interior impoundments and tributaries.

FORAGING: Major foods: Winter — crustaceans and mollusks (90 percent of diet), fish, seeds of pondweeds (*Potamogeton*), widgeon grass (*Ruppia*), and bulrush (*Scirpus*) (Erskine 1971). Substrates: Water. Techniques: Diving. Preferred feeding habitat: Shallow water 4 to 15 feet (1.2 to 4.6 m) deep over tidal flats and in large open bodies of water.

KEY REFERENCES: Bellrose 1976, Erskine 1971, Palmer 1976 V. 3.


Wooded Merganser

Lophodytes cucullatus)

D.U. No. 131.0



Range

 Breeding



RANGE: Breeding: Southern Nova Scotia s. to Florida, w. to the Great Plains and British Columbia. Winter: Nova Scotia (few) s. to Florida. Largest numbers winter s. of Connecticut. Also inland open water.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon and local in breeding season.

HABITAT: Breeding: Heavily wooded ponds, lakes, rivers, streams, wooded swamps. Flooded shores with dead standing trees and stumps and wooded clear water swamps are ideal habitat. Wintering: Ponds, fresh and brackish marshes, coastal brackish bays. Avoids salt water.

NESTING HABITAT REQUIREMENTS: Wooded areas with trees for nesting. Clear fresh water containing small invertebrates. Little or no human disturbance. Minimum diameter of suitable nest tree is 15 inches (38.1 cm) (Thomas et al. 1979).

REPRODUCTION: Egg dates: April 25 to July 2, New York (Bull 1974:152). Clutch size: 8 to 12, typically 10. Incubation period: 29 to 37 days. Nestling period: 1 day (Precocial). Broods per year: 1. Age at sexual maturity: Probably 2 years. Nest site: Normally nests in a natural tree cavity or a hole in a Woodpecker hole. The size, shape, and depth of cavity seem to be unimportant (Bent 1923:23). Merganser readily accepts nest boxes. Nest site is usually over water close to the water's edge.

SAMPLE DENSITIES: Average 2.14 broods per mile (0.6 km) of river. Highest densities occurred on heavily wooded rivers — lowest densities were found on marshy rivers (Kitchen and Hunt 1969). Density may be related to availability of food rather than nest sites (Kitchen and Hunt 1969).

FORAGING: Major foods: Cottam and Uhler (1937 in Palmer 1976:459) found that the contents of 138 stomachs contained: fishes (44 percent), crayfish (22 percent), other crustaceans (10 percent), aquatic insects (13 percent), and vegetable matter (4 percent). Substrates: Water, muddy and stony bottoms. Technique: Diving. Preferred feeding habitat: Clear shallow water, usually less than 25 inches (63.5 cm) deep.

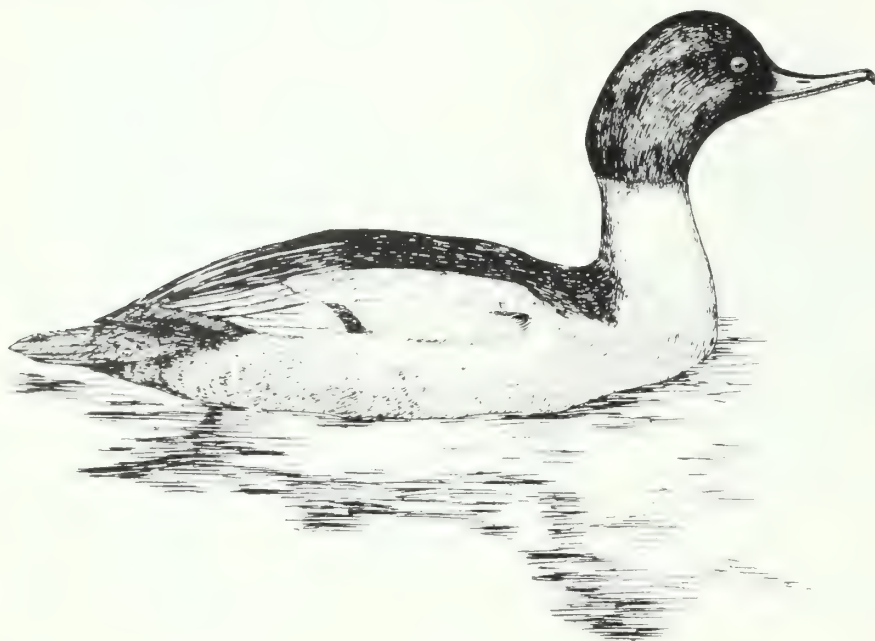
COMMENTS: The draining of wetlands, removal of snags, and pollution of water are human activities that have contributed to habitat loss.

KEY REFERENCES: Bellrose 1976, Bent 1923, Johnsgard 1975, Palmer 1976 V. 3.


Common Merganser

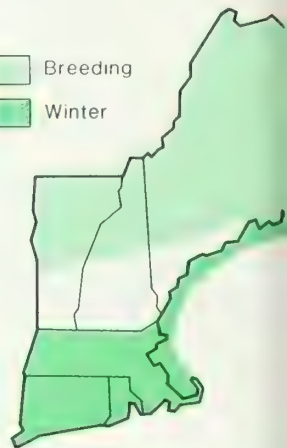
(*Mergus merganser*)

A.O.U. No. 129.0



Range

-  Breeding
-  Winter



RANGE: Breeding: Northern Maine, n. New Hampshire, n. Vermont and n. New York w. to n. Michigan and Minnesota, into Canada. Occasionally s. to c. Massachusetts. Rarely to Catskill and Pocono Mountains. Winter: Maritime provinces s. to Virginia (few to Florida). Greatest concentrations occur in Lake Ontario and Niagara River regions of New York, and open inland water in New Hampshire.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Clear water ponds, lakes and rivers with forested shorelines. Wintering: Prefers fresh and brackish waters of rivers, lakes, ponds, and bays.

SPECIAL HABITAT REQUIREMENTS: Clear water for visibility while feeding. Large trees (minimum diameter 20 inches) with cavities for nesting (Thomas et al. 1979). Little or no human disturbance.

NESTING: Egg dates: May 5 to July 10, New York (Bull 1974:155). Clutch size: 6 to 17, typically 9 to 12. Incubation period: 32 to 35 days. Nestling period: 1 to 2 days (precocial). Broods per year: 1. Age at sexual maturity: Probably 2 years. Nest height: To 50 feet (15 m) or more. Nest site: Usually in a natural tree cavity or abandoned Pileated Woodpecker hole at any height. Sometimes on ground in holes in banks, on cliffs or piles of rocks. Ground nests are well hidden under low limbs, overhanging rocks or dense shrubs. Nests are usually placed close to water. Accepts nest boxes.

HOME RANGE: No size information. Pairs are generally widely spaced, probably because of feeding requirements.

SAMPLE DENSITIES: 1 or 2 pairs per 16 mile (25.6 stretch of river in Michigan (Parmalee 1954). 34 pair 2.3 square miles (34 pairs/6 km²) on islands off Fire coast (Hilden 1964).

FORAGING: Major foods: Fishes (staple), mollusks (ter). Substrates: Water, submerged terrain. Techniques: Diving, immersing head. Preferred feeding site: Calm to rapid flowing shallow water 1.5 to 6 feet to 1.8 m) deep (Johnsgard 1975:514).

COMMENTS: Small groups have been known to cooperatively drive small fish into shallow water for easy capture (Johnsgard 1975:514).

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Pa 1976 V. 3.

Red-breasted Merganser

(*Lergus serrator*)

O.U. No. 130.0



Range

- Breeding
- Winter



DISTRIBUTION: Breeding: Northern Maine, New Hampshire, Vermont, and New York w. to n. Minnesota, n. into Canada. Atlantic coast s. to Massachusetts and Long Island (Bull 1974:158). Winter: Atlantic coast from the Maritime Provinces s. to Florida. Greatest numbers in the northeast occur in the Long Island area.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon in breeding season, common in winter.

HABITAT: Breeding: Rivers, streams, ponds, and lakes in wooded areas and on coastal islands. Ideal habitat is a small island with low woody growth or low-hanging conifers. Wintering: Mainly coastal waters, bays and inlets, but avoids deep or rough water. Less commonly seen in inland waters.

ENVIRONMENTAL HABITAT REQUIREMENTS: Clear water for visibility when feeding.

REPRODUCTION: Clutch size: 5 to 16, typically 8 to 10. Incubation period: 26 to 28 days. Nestling period: 1 day (precocial). Broods per year: 1. Age at sexual maturity: 2 years. Nest site: Highly variable from marshes to rocky, treeless

islets. On ground under shrubs or in terrestrial cavity under large rocks or driftwood. Usually within 25 feet of water. Favors areas with scattered boulders. Accepts nest boxes.

SAMPLE DENSITIES: Birds are usually solitary, but at an ideal site 6 to 10 birds will nest closely. Greater densities have been found on islands than on mainland of Iceland (Bengtson 1970).

FORAGING: Major foods: Fishes (staple), crustaceans, aquatic insects, worms, fish eggs. Substrates: Water, submerged terrain. Techniques: Diving, immersing head. Preferred feeding habitat: Shallow, sandy shores just beyond breakers (coast), inlets and river mouths.

COMMENTS: Groups engage in cooperative feeding by driving schools of fish into shallow water where they can be caught more easily (Bellrose 1976:453).

KEY REFERENCES: Bellrose 1976, Johnsgard 1975, Palmer 1976 V. 3.


Turkey Vulture

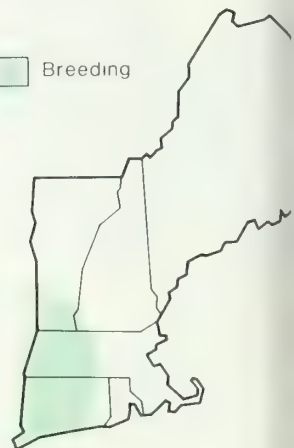
(*Cathartes aura*)

A.O.U. No. 325.0



Range

 Breeding



RANGE: Breeding: Central New York, Connecticut and w. Massachusetts, w. to British Columbia, s. to South America. Winter: Maryland and New Jersey, w. to Ohio.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common, numbers increasing.

HABITAT: Breeding: Various habitats, including wet, dry, open, and wooded. Wooded habitat is dominated by deciduous or mixed trees. Wintering: Similar to breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Clearings such as fields and roads in which carrion can be easily sighted.

NESTING: Egg dates: May 4 to June 30, New York (Bull 1974:166). Clutch size: 1 to 3, typically 2. Incubation period: About 30 days. Nestling period: 70 to 84 days (Kempton 1927—2 broods). Broods per year: 1. Nest site: On rocky outcrops or ledges or in rocky caverns, in hollow tree trunks or logs in open deciduous woodlands. Eggs are usually well hidden from view and inaccessible to predators. Females show attachment to old nest sites.

SAMPLE DENSITIES: Probably fewer than 2 or 3 birds per square miles (1 bird/km²) at southern part of range (Forbush and May 1939:95). 0.3 pairs per 100 acres (40 ha) in mixed habitat (forest-brush-farmland) in Maryland (Stewart and Robbins 1958:105).

FORAGING: Major foods: Carrion of amphibians, reptiles, birds, mammals, and fish; also eats small quantities of plant material. Substrates: So variable that no single


substrate can be emphasized except perhaps roads because of their many road kills. Technique: Soar. Preferred feeding habitat: Open fields, ridges.

COMMENTS: The Turkey Vulture's recent range extension and population increase in the Northeast may be related to warmer climate, more deer, and more highway cause road kills (Bull 1964:148). Birds frequent mountain ridges and valleys in search of food. They use snags for roosting and preening.

KEY REFERENCES: Bent 1937, Forbush and May 1939, Kempton 1927, Todd 1940, Work and Wool 1942.



Range

 Breeding



RANGE: Breeding: Practically worldwide. In the Eastern United States, birds breed from Maine to Florida. Ospreys are scattered and uncommon except at traditional coastal breeding areas where scores may nest. Winter: Florida and the Gulf States, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common but generally uncommon to rare.

HABITAT: Breeding: Near large bodies of water that support abundant fish. Birds nest along rivers and lakes but the highest densities occur along the coast at estuaries.

SPECIAL HABITAT REQUIREMENTS: Clean water with adequate supply of fish. Elevated nest sites.

REPRODUCTION: Egg dates: April 27 to June 21, New York (Bull 1977:169). Clutch size: 2 to 5, typically 3. Incubation period: About 28 days. Age at first flight: 8 to 10 weeks. Eggs per year: 1. Age at sexual maturity: 3 years. Nest site: To 130 feet (39.6 m). Nest site: A variety of places but all dead trees are most often chosen. Other sites include rocky ledges, sand dunes, telephone pole cross-arms, and artificial platforms. All are taller than surrounding land and provide good vantage points. Some are loosely colonial.

TERRITORY SIZE: Undetermined. A pair defends the immediate nest site from other Ospreys (Ogden 1975).

POPULATION DENSITIES: Nests may be grouped as close as 65 feet (20 m) (Ogden 1975). Active nests in the Adirondacks (New York) ranged from 4.5 to 20 miles (7.2 to 32 km) apart (Singer 1974).

FORAGING: Major food: Fish. Substrate: Water. Techniques: Hovering and diving, slow level flying 50 to 100 feet (15.2 to 30.5 m) above water. Preferred feeding habitat: Shallow water areas of streams, shoals of lakes (where fish are close to surface).

COMMENTS: Ospreys show strong attachment to breeding grounds, returning to the same nest or area year after year. The Osprey population in the lower Connecticut River-Long Island area is increasing in response to the DDT ban and egg transplants from Maryland birds.

KEY REFERENCES: Bent 1937, Forbush 1929, Ogden 1975.

Bald Eagle

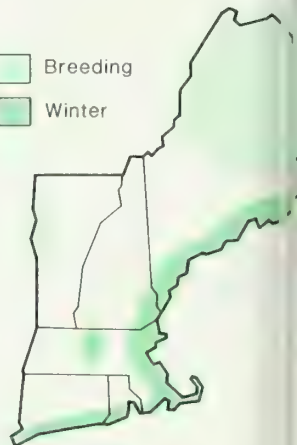
(*Haliaeetus leucocephalus*)

A.O.U. No. 352.0



Range

Breeding
 Winter



RANGE: Breeding: Once bred throughout North America, but today occurs mainly in Alaska, near the Great Lakes, Chesapeake Bay and in s. Florida. In Maine nests s. to Merrymeeting Bay and on Swan Island (P. Cross, personal communication). Winter: Southern Canada, w. to Alaska, s. to Florida and s. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and endangered.

HABITAT: Breeding: Forests and open areas, mountains, usually near large bodies of water with abundant fish. Wintering: Coast, and inland where ice-free waters allow access to fish. Also ice-bound lakes where birds feed on carrion such as deer carcasses. Birds congregate at night roosts and feeding areas.

SPECIAL HABITAT REQUIREMENTS: Large bodies of water that contain fish, large living trees for nesting. Pilot tree (access points to and from nest) and perch trees are important. Insolation from human disturbance may be a habitat requirement (U.S. Forest Service 1977).

NESTING: Egg dates: March 6 to May 14, New York (Bull 1974:174). Clutch size: 1 to 3, typically 2. Incubation period: About 35 days. Nestling period: 72 to 74 days (Bent 1937). Broods per year: 1. Age at sexual maturity:

3 years. Nest height: 35 to 100 feet (10.7 to 30.5 m). Usually 50 to 60 feet (15.2 to 18.3 m). Nest site: An open place 5 to 30 feet (1.5 to 9.1 m) below the top of a very tall living tree. Tree species is not as important as size, exposure and proximity to other nesting Eagles. Sites with an unobstructed view of surrounding terrain are preferred. The nest is often used year after year. Occasionally uses cliffs for nesting.

TERRITORY SIZE: A pair of southern Bald Eagles defended an area that extended 0.5 mile (0.8 km) in all directions from the nest (Broley 1947). Usually a minimum of several square miles in area (Pough 1951:158).

FORAGING: Major foods: Fish (staple), small to medium mammals, large birds, turtles, carrion. Substrates: water, ground. Techniques: Soaring, hawking, hovering and diving, wading. Preferred feeding habitat: Lakes, rivers, coastal bays, and inlets.

COMMENTS: Bald eagles use snags for perching. They show strong attachment to old nesting territories and nest sites. When nest is destroyed they often rebuild nearby. When suitable trees are lacking, they may resort to small weak trees (Broley 1947).

KEY REFERENCES: Bent 1937, Broley 1947, Forbush 1919.

Northern Harrier

(*Circus cyaneus*)

D.U. No. 331.0



Range

- Permanent
- Breeding



RANGE: Breeding: Quebec, s. to se. Virginia and w. Winter: Southern New England, w. across the continent s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to locally common at coastal marshes.

HABITAT: Breeding: Open country, fresh or salt marshes, swamps and bogs, wet meadows. Wintering: Coastal marshes.

SPECIAL HABITAT REQUIREMENTS: Open country with herbaceous or low woody vegetation for nest concealment.

REPRODUCTION: Egg dates: April 20 to June 25, New York (Bull 1974:177). Clutch size: 3 to 9, typically 4 to 6. Incubation period: About 24 days. Age at first flight: 5 to 6 weeks. Broods per year: 1. Nest site: On ground in tidal marshes, dry fields, cut-over areas, swamps with low shrubs and clearings, sometimes built up over water on a mud foundation, sedge tussock or willow clump. Foundation of nest may be 18 inches (45.7 cm) high in wet situations (Harrison 1975:39).

TERRITORY SIZE: Unknown. Birds defend nest areas from marsh hawks and other species.

HOME RANGE: 0.38 square mile (.98 km²) to 3.89 square miles (10.1 km²) in Michigan (Craighead and Craighead 1966:259, 260). Winter range: 0.55 square mile (1.4 km²) to 0.63 square mile (1.6 km²) for a pair and a single bird, respectively (Craighead and Craighead 1966:26).

SAMPLE DENSITIES: 3 pairs nested within 400 yards (366 m) of each other (Bent 1937). 4 pairs per square mile (1.5 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FORAGING: Major foods: Small mammals (staple), especially rodents, shrews and lagomorphs, small birds, amphibians, reptiles, insects, and occasionally carrion. Substrate: Meadow grasses. Techniques: Hovering and diving, quartering low over the ground.

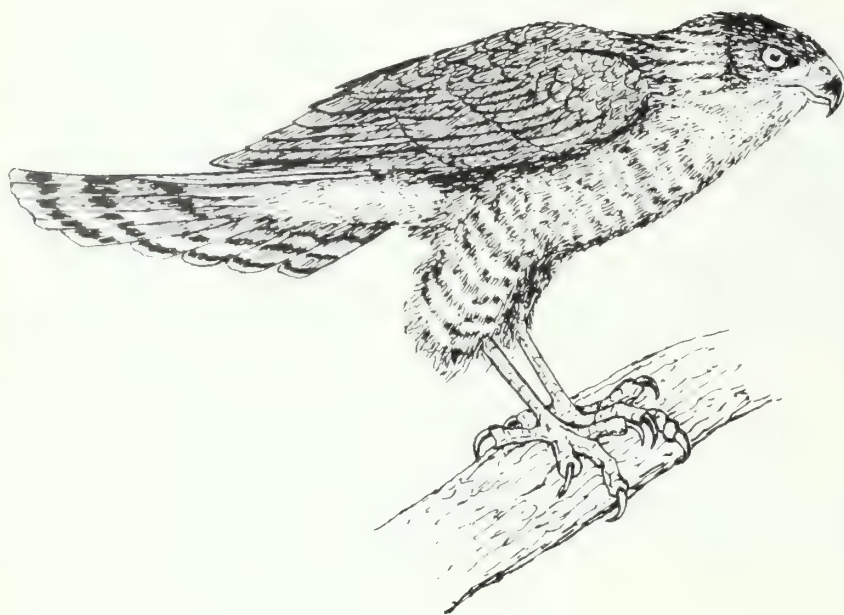
COMMENTS: Possibly mates for life. Males are occasionally polygynous, defending two nests in the same area. Marsh hawks generally roost on ground or perch on very low objects such as fence posts and tree strumps. Populations have recently declined in New York State (Bull 1974:177).

KEY REFERENCES: Bent 1937, Hausman 1966, Hecht 1951, Randall 1940.



Sharp-shinned Hawk

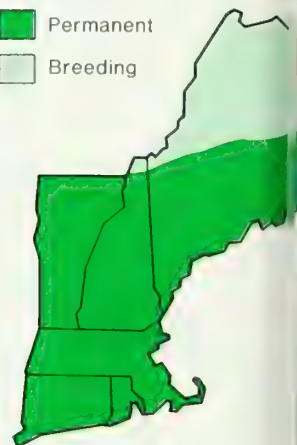
(*Accipiter striatus*)

A.O.U. No. 332.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland s. to Georgia (mountains), and w. Winter: Central New England w. to Ohio and s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Maine) in breeding season. Uncommon to rare in winter.

HABITAT: Breeding: Open mixed or coniferous woodlands, clearing, edges. A bird of cold-temperate conifer forests and temperate deciduous woodlands. Wintering: Same as breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Extensive open mixed woodlands that are free from human disturbance.

NESTING: Egg dates: April 16 to June 21, New York (Bull 1974:179). Clutch size: 3 to 8, typically 4 or 5. Incubation period: 21 to 24 days. Nestling period: 24 to 27 days (males 24 days, females 27 days (Platt 1976). Broods per year: 1. Nest height: 6 to 90 feet (1.8 to 27.4 m), typically 30 to 35 feet (9.1 to 10.7 m). Nest site: Most often in a conifer (white pine in Massachusetts, hemlock in New York) (Bent 1937:96, Bull 1974:179). Seldom in a deciduous tree (oak, beech). Nest is typically placed on a limb against the trunk of a medium tree and is well concealed. Nest tree is often at the edge of a clearing. Sometimes repairs and uses an old nest.

HOME RANGE: 0.26 square mile to 0.51 square miles in Moose, Wyoming (Craighead and Craighead 1969:263).

FORAGING: Major foods: Small to medium birds (starlings), small mammals, mainly rodents, shrews, moles and young lagomorphs. Substrates: Forest floor, meadows, grasses, bushy pastures. Techniques: Hawking, diving to ground and pouncing. Preferred feeding habitat: Generally forages over open country — avoids hunting in heavily wooded areas.

COMMENTS: Platt (1976) found that Sharp-shinned Hawks' nests in Utah were most often placed in dense small conifer groves that were surrounded by deciduous trees. Often in heavily wooded areas in New York State (Bull 1974:179).

KEY REFERENCES: Bent 1937, Craighead and Craighead 1969, Mendall 1944, Platt 1976.

Cooper's Hawk

(*Accipiter cooperii*)

O.U. No. 333.0



Range

- Permanent
- Breeding



AGE: Breeding: Nova Scotia w. to w. Ontario, s. to Florida and the Gulf Coast. Winter: Southern New England and Ohio, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon in Massachusetts to rare (Maine) in breeding season.

HABITAT: Breeding: Extensive deciduous or mixed woodlands that are dense or open, scattered woodlots interspersed with open fields. Occupies similar forest type as Sharp-shinned Hawk but has broadened its habitat by moving into more open agricultural areas. Flooded forests and wooded swamps. Wintering: Similar to breeding habitat.

REPRODUCTION: Egg dates: April 20 to June 16, New York (Bull 1974:179). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 24 days. Nestling period: 21 to 25 days. Broods per year: 1. Nest height: 20 to 60 feet (6.1 to 18.3 m), usually 35 to 45 feet (10.7 to 13.7 m). Nest site: In a cavity (often white pine), but more often in a hardwood tree. Nest is commonly placed on a horizontal branch or crotch near the trunk. Frequently uses old crow nests. Cooper's Hawks often return to same nest site year after year (Bull 1974:179).

HOME RANGE: 0.07 square mile (0.2 km²) to 2.05 square miles (5.3 km²) in Michigan (Craighead and Craighead 1969:258, 260). Average winter range: 1.5 to 2 miles (2.4 to 3.2 km) in diameter (Craighead and Craighead 1969).

SAMPLE DENSITIES: 0.2 pairs per 100 acres (40 ha) in mixed forest-farmland habitat in Maryland (Stewart and Robbins 1958:110).

FORAGING: Major foods: Small to medium birds and small mammals, especially rodents and young lagomorphs; occasionally eats insects and amphibians. Substrates: Forest floor, meadow grasses. Techniques: Hawking, diving to ground and pouncing. Preferred feeding habitat: Cooper's Hawks hunt primarily in woodlots away from nest area and in open areas near woodland.

COMMENTS: Cooper's hawks usually hunt on the wing low to the ground or just above tree-top level.

KEY REFERENCES: Bent 1937, Craighead and Craighead 1969, Forbush 1929.



Northern Goshawk

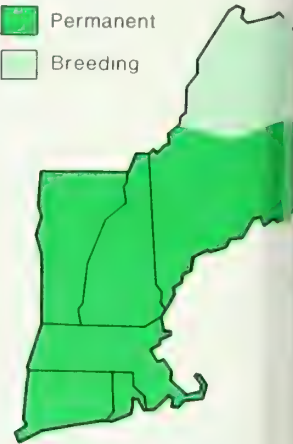
(*Accipiter gentilis*)

A.O.U. No. 334.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Canada s. to New York, nw. Connecticut and Pennsylvania and w. to Lake Erie. Winter: Southern Canada, s. to Virginia and Illinois.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Interiors of remote and heavily forested areas, coniferous and mixed forests. Wintering: Same as breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Extensive mixed woodlands with large trees for nesting.

NESTING: Egg dates: April 20 to May 15, New York (Bull 1974:182). Clutch size: 2 to 5, typically 3 or 4. Incubation period: About 28 days. Nestling period: About 42 days. Broods per year: 1. Nest height: 20 to 75 feet (6.1 to 22.9 m), typically 30 to 40 feet (9.1 to 12.2 m). Nest site: Prefers to nest in a hardwood tree in mixed woodlands. Nest may be placed in a crotch close to trunk or out on a limb. Often builds in beech, birch, poplar, or occasionally pine or hemlock. Builds on top of old nest (own or other hawk's) or makes new nest.

HOME RANGE: 0.82 square miles (2.1 km²) (observed area) in Moose, Wyoming, in 1947 (Craighead and Craighead 1969:263).

FORAGING: Major foods: Small to medium birds (starlings, sparrows, etc.), mammals, especially rodents and lagomorphs. Foraging strates: Ground, trees and shrubs, air. Techniques: Hawking, diving to ground and pouncing. Preferred feeding habitat: Clearings and brushy openings.

COMMENTS: Caches food. Birds are able to maneuver through dense woods in search of prey. 28 of 37 (76 percent) of goshawk stomachs in Maine contained the remains of small birds (Mendall 1944). Numbers of breeding birds recently increased greatly in the mountains of New York (Bull 1974:180).

KEY REFERENCES: Bent 1937, Craighead and Craighead 1969, Forbush and May 1939.

Red-shouldered Hawk

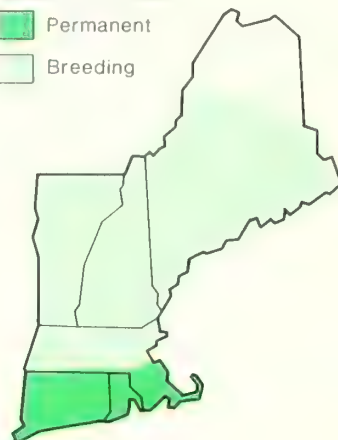
(*Buteo lineatus*)

O.U. No. 229.0



Range

- Permanent
- Breeding



RE: Breeding: Throughout the Eastern United States. Winter: Southern New England w. to Michigan,

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Moist hardwood or mixed woodlands, wooded swamps, bottomlands and wooded marshes often close to cultivated fields. Rare in mountains. Wintering: Same as breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Cool, moist, lowland forests with tall trees for nesting.

REPRODUCTION: Egg dates: March 25 to May 26, New York (Bull 1971:186). Clutch size: 2 to 4, typically 3. Incubation period: 28 days. Nestling period: 35 to 42 days. Broods per year: 1. Nest height: 20 to 60 feet (6.1 to 18.3 m), usually 35 to 45 feet (10.4 to 13.7 m). Nest site: Shows no preference for any one species of tree for nesting but usually chooses one that is tall. Nest is typically located in a main fork close to trunk. May repair and use old nest but usually builds new one. Birds show strong attachment to nest site by returning year after year.

HOME RANGE: 180 acres (72.9 ha) in Kansas (Fitch 1958). 0.3 square mile to 0.60 square mile (0.07 to 1.6 km²) in Michigan. Winter ranges in Michigan were usually between 1.5 and 2 square miles (3.8 to 5.2 km²) (Craighead and Craighead 1969:24).

SAMPLE DENSITIES: 1 pair per 0.8 square miles (1 pair/2.1 km²) in floodplain forest in Maryland (Stewart 1949).

About 1 pair per 120 acres (48.6 ha) of floodplain in Maryland (Henny et al. 1973).

FORAGING: Major foods: Amphibians, reptiles, crustaceans (crayfish), insects, mammals such as small rodents, shrews, and moles. Also takes young birds of many species. Substrates: Forest floor, meadow grasses. Techniques: Hawking (while soaring or sallying from a perch), diving to ground and pouncing. Preferred feeding habitat: In addition to foraging in nesting habitat, birds hunt in drier woodland clearings and fields.

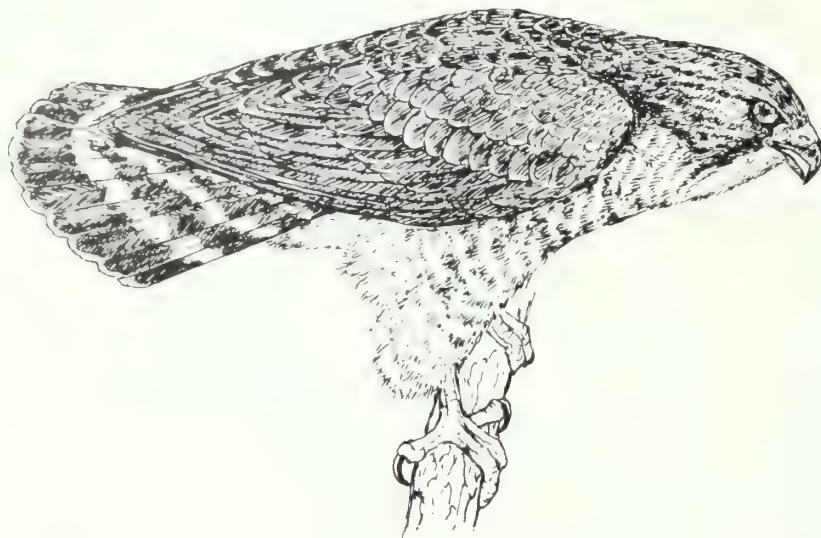
COMMENTS: Pairs may remain mated for life. In Massachusetts, Red-shouldered Hawks nested in dry woods both near and away from water (Bent 1937:184).

KEY REFERENCES: Bent 1937, Craighead and Craighead 1956, Ernst 1945, Henny et al. 1973, Stewart 1949.

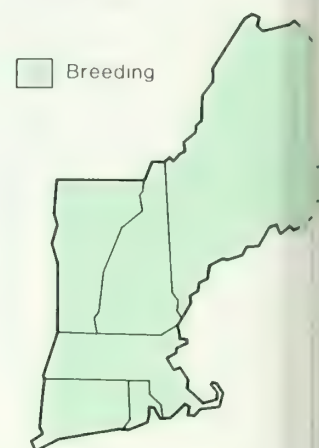
Broad-winged Hawk

(*Buteo platypterus*)

A.O.U. No. 343.0



Range



RANGE: Breeding: Throughout the Eastern United States from s. Canada to the Gulf States. Winter: Southern tip of Florida, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Dry forests (mostly deciduous and mixed, occasionally in conifers), wooded hillsides generally away from human habitations. Prefers continuous woods, shuns open country. Seems to prefer to nest along untraveled woods roads, at least in New England.

SPECIAL HABITAT REQUIREMENTS: Extensive woodlands (Bull 1974:188).

NESTING: Egg dates: April 27 to June 26, New York (Bull 1974:188). Clutch size: 1 to 4, typically 2 or 3. Incubation period: 28 to 35 days. Nestling period: 29 to 30 days. Broods per year: 1. Age at sexual maturity: 2 years. Nest height: 3 to 80 feet (1.0 to 24.4 m). Typically 24 to 40 feet (7.3 to 12.2 m). Nest site: Shows little preference for kind of nest tree — generally choosing one of the largest and most abundant species. Typically locates nest in crotch next to trunk.

FORAGING: Major foods: Amphibians, reptiles, insects, small mammals such as shrews (staple) and mice, occasionally takes young birds. Substrate: Forest floor. Techniques: Hawking, soaring, diving, and pouncing. Preferred feeding habitat: Prefers deep, shady woodlands, sometimes ventures out over meadows.

COMMENTS: Possibly mates for life. 14 trees supporting nests in deciduous woods in New York had a mean diameter of 21.3 inches (54.1 cm) (range 16.6 to 29.2 inches) (4 to 74.2 cm). The hawks showed a preference for nesting in yellow birch (Matray 1974).

KEY REFERENCES: Bent 1937, Burns 1911, Matray 1974

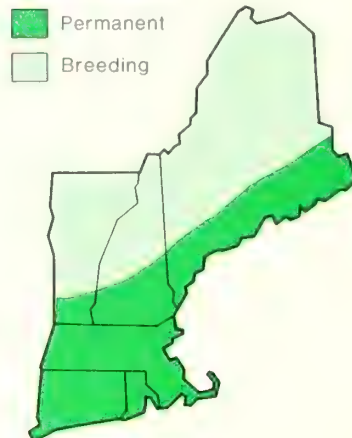
Red-tailed Hawk

(*Bubo jamaicensis*)

U. No. 337.0



Range



DISTRIBUTION: Breeding: Alaska and Canada s. to Central America and the West Indies. Winter: Withdraws from northern portions of breeding range to c. New England and Michigan, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Massachusetts) to uncommon (Maine) in breeding season. Common to uncommon in winter.

HABITAT: Breeding: Deciduous and mixed woodlands interspersed with meadows, brushy pastures, open bogs, and swampy areas. Common to both the cold-temperate conifer forests and temperate deciduous woodlands. Foraging: Similar to breeding habitat.

NESTING HABITAT REQUIREMENTS: Large trees for nesting and perching.

REPRODUCTION: Egg dates: March 8 to May 16, New York (Bull 1948). Clutch size: 1 to 5, typically 2 or 3. Incubation period: About 28 days. Broods per year: 1. Age at first flight: 4 to 5 weeks. Nest height: 35 to 90 feet (10.7 to 27.4 m). Nest site: Usually in a tall tree in or at the edge of a wood, or in isolated tree in an open situation. Oak or white pine is often used as nest tree in Massachusetts. In New York, beech, birch, and maple are commonly used (Bull 1937:151-152).

HOME RANGE SIZE: 80 to 200 acres (32.4 to 81.0 ha) (excluding peripheral areas) in California (Fitch et al. 1946).

HOME RANGE: Breeding season: 0.30 square mile (minimum) to 2.15 square miles (maximum) (0.8 to 5.6 km²) in

Wyoming and Michigan, respectively. Winter: Ranges of up to 4 square miles (10.4 km²) were measured in Michigan (Craighead and Craighead 1969:24, 260, 263).

SAMPLE DENSITIES: 1 pair per 2.2 square miles (1 pair/5.7 km²) in deciduous woodland in New York (Hagar 1957). 1 pair per 4.1 square miles (1 pair/10.6 km²) in fields and woodlands (Gates 1972). 1 pair per 0.5 square mile (1 pair/1.3 km²) in pine-oak habitat in California (Fitch et al. 1946).

FORAGING: Major foods: Small mammals, especially rodents such as meadow mice, chipmunks, and squirrels; also takes amphibians, reptiles, nestling birds, insects, and carrion; occasionally kills domestic animals (Orlans and Kuhlman 1956). Substrates: Short meadow grasses. Techniques: Soaring, diving, and pouncing. Preferred feeding habitat: Open field with short grasses and weeds and scattered trees for perching.

COMMENTS: Birds possibly mate for life. Red-tails generally select the largest and tallest trees for nesting (over 35 feet (10.7 m) tall). They utilized small woodlots in New York State, the smallest being 15 acres (6.1 ha). Occasionally they used isolated trees up to 50 yards (45.7 m) from woods (Hagar 1957). Gregarious in winter.

KEY REFERENCES: Craighead and Craighead 1969, Fitch et al. 1946, Gates 1972, Hagar 1957, Orlans and Kuhlman 1956.

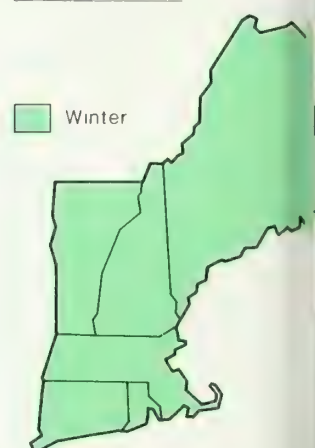
Rough-legged Hawk

(*Buteo lagopus*)

A.O.U. No. 347.0



Range



RANGE: Breeding, Arctic North America. Winter: Arctic, s. to North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare but sometimes very common in winters when northern foods are scarce.

HABITAT: Wintering: Restricted to open areas, bushy fields, open meadows and marshes, especially in coastal areas. Generally very infrequent inland in southern New England. Needs open snowless areas (C. Anderson, personal communication).

SPECIAL HABITAT REQUIREMENTS: Open country.

HOME RANGE: Winter: Ranges of two birds in Michigan were 0.68 square miles (1.8 km²) and 1.69 square miles (4.4 km²). The usual range may be 6 square miles (10.4 to 15.5 km²) (Craighead and Craighead 1969:23).

FORAGING: Major foods: Winter — mammals, especially mice and shrews (staple). Also feeds on carrion. Substrates: Open ground — fields, pastures. Techniques: Hovering, hawking, pouncing. Preferred feeding habitat: Grassy areas, fallow fields.

COMMENTS: Numbers declined in the early part of the 20th century because of wholesale slaughter brought about by the belief that all raptors were chicken and game bird killers. Rough-legged Hawk populations are

highly irruptive with largest numbers generally occurring during years of meadow mouse (*Microtus*) abundance (Bull 1974:189). This species is more numerous from central New York west to the Lakes Region.

KEY REFERENCES: Bent 1937, Craighead and Craighead 1969, Forbush 1929.

Golden Eagle

quila chrysaetos)

D.U. No. 349.0



Range



GE: Breeding: Edge of arctic tundra across North America, s. to the mountains of North Carolina, Mexico, and California. Has nested in Vermont, New Hampshire, and Maine. Winter: Withdraws from northernmost parts of breeding range.

EATIVE ABUNDANCE IN NEW ENGLAND: Very rare in all regions.

HABITAT: Breeding: Cold-temperate conifer forests, rugged mountain ranges near open land for hunting. Wintering: Timbered portions of New England with open spaces for hunting.

SPECIAL HABITAT REQUIREMENTS: Elevated nest sites, especially cliffs. Broad expanses of open land for hunting.

REPRODUCTION: Clutch size: 1 to 4, typically 2 or 3. Incubation period: About 43 days. Age at first flight: 12 weeks. Eggs per year: 1. Nest site: Usually on a cliff, crag, or rock commonly in a large tree. Pairs often attend alternate unoccupied nests in the vicinity of active nest, until eggs are laid.

TERRITORY SIZE: 20 to 60 square miles (51.8 to 155.4 km²) or an average of about 36 square miles (93.2 km²) (Beecham 1951:155).

HOME RANGE: 50 to 100 square miles (130 to 259 km²) (Spofford 1971).

SAMPLE DENSITIES: 56 breeding pairs per 240-km (149-mile) stretch of Snake River in Idaho. 1 pair per 8 km (5.0 miles) of river (Craighead and Craighead 1969). 1 pair per 5 km (3.1 miles) of river (Spofford 1971). Density is probably a function of availability of suitable nest sites, adequate prey, and minimum nesting territory size (Beecham and Kochert 1975).

FORAGING: Major foods: Small to medium mammals (preferred), medium to large birds, reptiles, carrion (when live food is scarce). Substrate: ground. Techniques: Soaring, diving, and pouncing. Preferred feeding habitat: Open country — burns, marshes, bogs, hillside meadows, bald knobs, and fields.

COMMENTS: Pairs probably mate for life. A few Golden Eagles breed in the Adirondacks of New York but very few young fledge (Spofford 1971). The bird is an irregular winter wanderer in the Northeast.

KEY REFERENCES: Beecham and Kochert 1975, McGahan 1968, Singer 1974, Woodgerd 1952.

American Kestrel

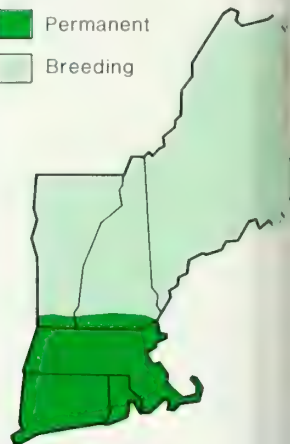
(*Falco sparverius*)

A.O.U. No. 360



Range

- Permanent
- Breeding



RANGE: Breeding: Newfoundland and Quebec, w. to Alaska, s. to South America. Winter: Central New England, w. and s. Northern limit of wintering population depends on snow depth.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Open areas with a few trees containing cavities, wet meadows, forest edges near open ground, orchards, farm buildings, cities. Wintering: Same as breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Nest trees with d.b.h. greater than 12 inches (30.5 cm) for nesting (Thomas et al. 1979). Open country with low vegetation. Elevated perches from which to sight prey. Snags.

NESTING: Egg dates: April 5 to June 29, New York (Bull 1974:202). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 29 to 31 days. Nestling period: 30 to 31 days. Broods per year: 1. Nest height: 4 to 50 feet (1.2 to 15.2 m), typically 10 to 35 feet (3.0 to 10 m). Nest site: In cavities of trees, under eaves of buildings, cliffs, rarely in old nests of other birds. Accepts man-made nest boxes. Roest (1957) found that kestrels frequently nested in abandoned flicker holes or natural cavities located 6.5 to 35 feet (2 to 10 m) above the ground.

TERRITORY SIZE: 351 acres (142 ha) (Hardin and Evans 1977).

HOME RANGE: Breeding and winter home ranges were of similar sizes in Wyoming. Both covered about 2 square

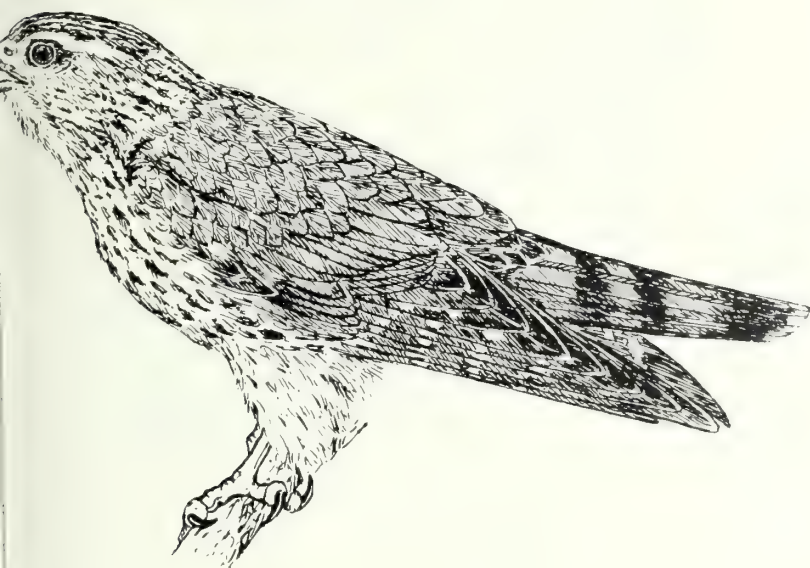
miles (5.2 km²) (Craighead and Craighead 1969). Average diameter of 7 home ranges was 0.31 mile (0.5 km) (Smith et al. 1972). Average diameter of 1.4 mile (2.2 km) for 4 nests in farming area (Enderson 1960).

SAMPLE DENSITIES: 33 pairs per 6.9 square miles (33 pairs/18 km²) in nest boxes in Holland (Brown 1976). 6 pairs per 0.5 square mile (6 pairs/1.3 km²) in nest boxes in Pennsylvania (Nagy 1963). Maximum pairs 0.28 per acre (40 ha) (Hardin and Evans 1977). 45 pairs per square mile (45 pairs/2.6 km²) in central Utah (Smith et al. 1972). 0.44 pairs per square mile (0.16 pairs/km²) in Michigan (Craighead and Craighead 1969).

FORAGING: Major foods: Insects (staple) especially grasshoppers, crickets and beetles; mammals such as small mice, shrews; small birds; reptiles, and amphibians. Substrates: Meadow grasses, air. Techniques: Hawking, hovering, diving to ground.

COMMENTS: Pairs possibly remain mated for life. Occasionally polygamy may occur (Roest 1957). Foot chasing is commonly practiced.

KEY REFERENCES: Balgooyen 1976, Bent 1938, Roest 1957, Smith et al. 1972, Willoughby and Kape 1960.



Range



RANGE: Breeding: Below timberline in Alaska and Canada to South Dakota and the tip of n. New York. Wintering: Gulf states and s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: Breeding: Open coniferous forest, marshes, fields in migration.

REPRODUCTION: Egg dates: May through June. Clutch size: 4. Incubation period: 30 days. Nest height: 35 to 60

feet (10 to 15 m). Nest site: On ledges, in tree cavities, on old nests of other birds (Harrison 1975:47).

FORAGING: Major foods: Small birds, small mammals, and insects. Substrates: Air, ground (grassy areas). Techniques: Perch and pounce or hawking. Preferred feeding habitat: hunts in a variety of open habitats—marshes, beaches, mudflats, and fields (Godfrey, 1979:103).

KEY REFERENCES: Bent 1938, Hausman 1966.

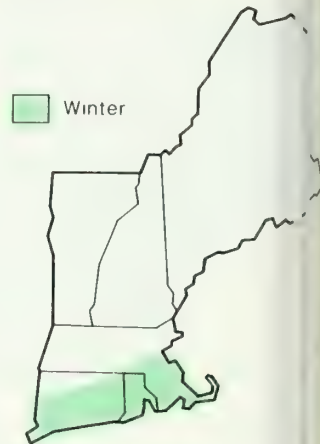
Peregrine Falcon

(*Falco peregrinus*)

A.O.U. No. 356.0



Range



RANGE: Breeding: Arctic North America, formerly s. to n. Georgia, and Texas but now believed to be extinct (as a breeding bird) in the Eastern United States. Winter: Massachusetts (rarely), w. to British Columbia, s. to n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and endangered.

HABITAT: Breeding: Typically on high, rocky cliffs of mountains; often near a river, stream, or other body of water; coastal bays. Sometimes breeds in cities. Birds commonly return to same nest site in successive years. Wintering: Birds winter primarily along the Atlantic Coast on barrier beaches. A few winter in cities, roosting on tall buildings.

SPECIAL HABITAT REQUIREMENTS: High cliffs for nesting, a clear view of surroundings, habitats free of harmful pesticides, ready supply of prey species, water within 0.5 to 1.0 mile (0.8 to 1.6 km) of nest site. Small amounts of gravel or soil in nest hollow may be required for laying (Bull 1974:196).

NESTING: Egg dates: March 26 to May 31, New York (Bull 1974). Clutch size: 2 to 6, typically 4. Incubation period: 30 days. Age at first flight: 5 to 7 weeks. Broods per year: 1. Nest site: Builds little or no nest. Lays eggs in a scraped depression on a rocky shelf on side of a high

ledge, cliff, bluff, or crag. Occasionally lays eggs on the broken top of a very large tree, roof or ledge of tall building.

SAMPLE DENSITIES: Hickey (1942) listed 19 pairs per 10,000 square miles (19 pairs/25,900 km²) around New York City. Average distance between pairs was about 1 mile (1.6 km) in an unusually dense island population along coast of British Columbia (Beebe 1960 in Hickey and Anderson 1969). About 1 pair per 2,000 square miles (1 pair/5,180 km²) was estimated for parts of North America where Peregrine was considered common and less than 1 pair per 20,000 square miles (1 pair/51,800 km²) where rare (Bond 1946 in Hickey and Anderson 1969).

FORAGING: Major foods: Small to large birds (step). occasionally takes mammals or dead fish. Substrate. Techniques: Hawking (grasping in midair) or striking in midair and recovering prey on ground.

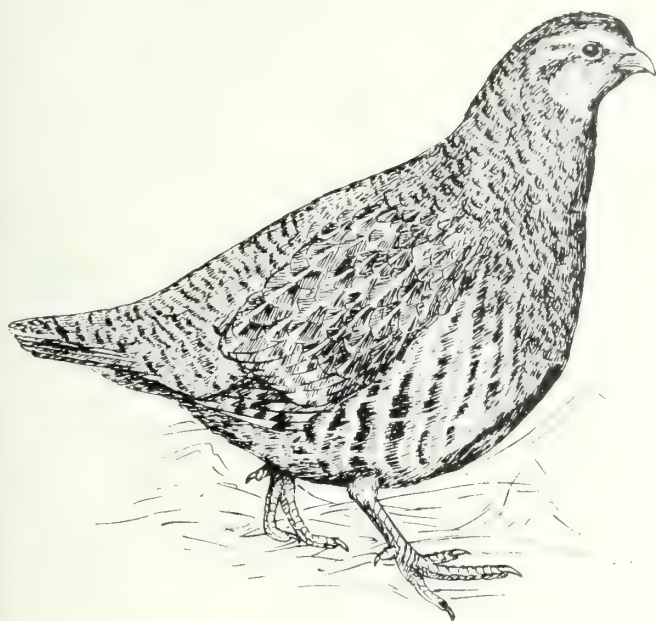
COMMENTS: Presently Peregrines are breeding in the Northeast only in coastal areas of New Jersey and the cliff site in New Hampshire. Recovery plans are the way to restore birds to their original breeding ranges. Releases have been made at a number of sites in Massachusetts, Vermont, New Jersey, New Hampshire and New York.

KEY REFERENCES: Brown 1976, Hausman 1966, Hickey 1942 and 1969.

Gray Partridge

(*Perdix perdix*)

O.U. No. 288.1



Range

 Permanent



RANGE: Breeding: A profusely stocked species with the highest populations in the northern Great Plains region from w. Wisconsin, w. to c. Montana and through s. Manitoba to se. Alberta. The northwest populations inhabit the agricultural areas of Washington, Oregon, and Idaho. Disjunct populations are in s. Wisconsin, n. Illinois, s. Michigan, ne. Indiana and nw. Ohio. Smaller colonies are established in n. New York, nw. Vermont, Pennsylvania, Nova Scotia, s. New Brunswick, and Prince Edward Island. Winter: same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Near the edges of hayfields and grain fields. Winter: Same as breeding habitat. Typically remain in open areas, but may seek shelter during periods of strong winds.

SPECIAL HABITAT REQUIREMENTS: Availability of grain crops and grasslands for nesting and brooding cover.

REPRODUCTION: Nest dates: Late April a nest is made in grassy cover. Edge is a strong influence on nest sites (Yeatter 1934). Egg dates: Mid- to late June (Edminster 1954:372). Clutch size: 16.4 average. Incubation period: 24 to 25 days. Brood period: The young are fully plumaged and grown in about 10 weeks (Edminster 1954:373).

SAMPLE DENSITIES: On three 160-acre study areas in Michigan, Yeatter (1934) reported one bird for 4.4, 11, and 13.3 acres. Some evidence of Gray Partridge populations following 10-year cycles of abundance, similar to native grouse species (Aldrich 1947).

FORAGING: Major foods: Green leafy materials, seeds of weedy herbs and cultivated grains. Insects occasionally taken by adults. Chicks insectivorous during the first 2 weeks of life (Edminster 1954:378). Grit required throughout the year.

COMMENTS: A native species of Europe and southwestern Asia. Originally introduced in the United States in the late 18th century.

KEY REFERENCES: Edminster 1954, Johnsgard 1973.

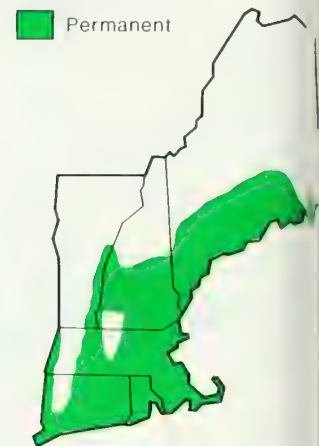
Ring-necked Pheasant

(*Phasianus colchicus*)

A.O.U. No. 309.1



Range



RANGE: Breeding: Central Maine, w. to British Columbia, s. to Maryland and Kentucky. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Massachusetts) to uncommon (Maine).

HABITAT: Breeding: Open cultivated fields of grass or grain, fallow fields, bushy pastures, hedgerows by roadsides, cut-over land, open ungrazed woodlots. Agricultural lands provide the best habitat. Absent in mountains, avoids forested areas. Wintering: Birds seek areas with dense protective cover, often swamps interspersed with thickets.

NESTING: Egg dates: April 14 to July 28, New York (Bull 1974:205). Clutch size: 6 to 15, typically 10 to 12. Incubation period: 23 to 25 days. Nestling period: Less than 1 day (precocial). Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: On ground in the open among weeds or cultivated hay or in bushy pastures.

TERRITORY SIZE: The male defends an area for courting, mating, and feeding (females may nest nearby or elsewhere). 11 territories ranged from 3 to 13 acres (1.2 to 5.3 ha) (Twining 1946).

SAMPLE DENSITIES: In the Northeast, densities ranged from less than 1 bird per 100 acres (40. ha) in poor habitat to more than 50 birds per 100 acres (40. ha) in optimum habitat (Allen 1956). At Pelee Island, Ontario, Stokes (1956:367) noted the following densities: 6.2

birds per acre (0.4 ha) in hayfield, 5.7 birds per acre (ha) in abandoned pasture and 12.4 birds per acre (ha) in weeds. In autumn, good habitat probably supports 10 to 15 birds per 100 acres (40. ha) (Studholme and Johnson 1956).

FORAGING: Major foods: Cultivated grains and weed seeds (staple), buds and soft parts of herbaceous vegetation, fleshy fruits, insects. Substrates: Ground litter, grasses and other low-growing plants, soft earth. Techniques: Gleaning, scratching, and pecking. Preferred feeding habitat: Grain fields and weed fields bordered by hedgerows which afford protective travel lanes.

COMMENTS: Pheasants were first successfully introduced from China to Oregon in 1881, but from England to the Northeast (Governor's Island, New York) as early as 1733. Males generally are polygynous; some have monogamous tendencies.

KEY REFERENCES: Allen 1956, Bent 1932.

Spruce Grouse

(*Partridge canadensis*)

D.U. No. 298.0



Range

Permanent



RANGE: Breeding: Northern Quebec, w. to Alaska, s. to Vermont, c. New Hampshire, Maine, n. Michigan, n. Washington. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Wooded tamarack swamps, cedar and muskegs, lowlands bordering sluggish streams and coniferous forests. Rarely uses open meadows or bogs. Wintering: Same as breeding habitat, but birds seek denser areas of forests in extreme cold.

SPECIAL HABITAT REQUIREMENTS: Dense conifers for cover and shelter.

REPRODUCTION: Egg dates: May 5 to June 24, se. Canada and Maine (Bent 1932: 129). Clutch size: 4 to 10, typically 6. Incubation period: 22 to 25 days. Nestling period: less than 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On ground in brush or under low-hanging conifer branches in open or dense conifer stands.

TERRITORY SIZE: 3 to 21 acres (1.2 to 8.5 ha) per territorial male in white spruce and paper birch habitat in Alaska (Ellison 1971)—these areas were used exclusively by males but were not necessarily defended.

HOME RANGE: May be as large as 100 ha (247 acres) for territorial males and 100 to 150 ha (247 to 370 acres) for females that have nested (Ellison 1973).

SAMPLE DENSITIES: Possibly 10 males per square mile (4 males/km²) in spruce-birch habitat in Alaska (Ellison 1971). 7 to 11 birds per 0.4 square mile (7 to 11 birds/km²) (spring density); 20 to 36 birds per 0.4 square mile (20 to 36 birds/km²) (autumn density) (Ellison 1973).

FORAGING: Major foods: Buds and needles of conifers (winter staple), insects, seeds, fruits and tender leaves of herbaceous plants, mushrooms. Substrates: Leaf litter of forest floor, high limbs of spruce (normally at least 15 to 20 feet (4.6 to 6.1 m)). Techniques: Scratching and pecking, budding.

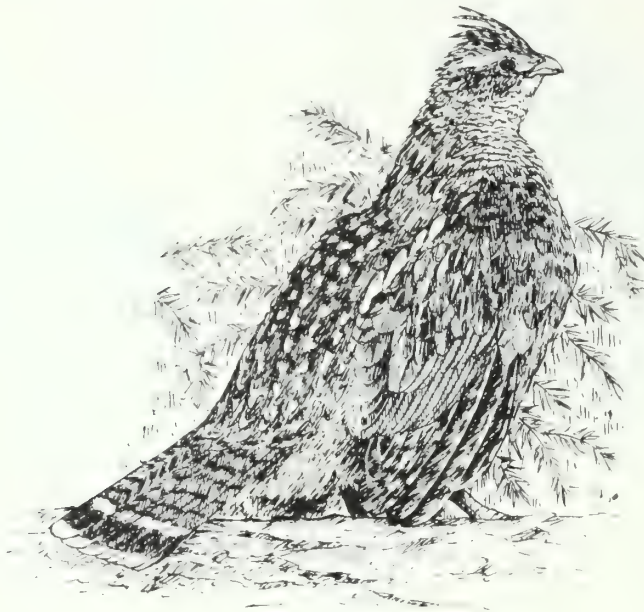
COMMENTS: Diet shifts in late summer and early autumn from nonconiferous materials to primarily coniferous ones.

KEY REFERENCES: Bent 1932; Ellison 1971, 1973; Forbush and May 1939; Fritz 1977.

Ruffed Grouse

(*Bonasa umbellus*)

A.O.U. No. 300.0



Range

 Permanent



RANGE: Breeding: Southern Quebec w. to Alaska, s. to Virginia and the mountains of n. Georgia. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Broods prefer areas with dense woody cover overhead and fairly open herbaceous ground cover. Broods frequent regenerating stands of aspen, birch, and other hardwoods. Alder thickets, recently logged areas next to shrubby wetlands, and abandoned farmlands in the shrub and sapling stage are particularly attractive to broods. In extensive stands of pole and sawtimber, broods frequent logging roads, small clearings, and recently disturbed sites. Wintering: Daytime activity usually occurs in shrubby thickets and dense stands of hardwood saplings. Birds prefer to roost in snow burrows in open pole-size hardwood stands. When snow is unsuitable for roosting, birds concentrate in dense brush or closed-canopy conifer stands.

SPECIAL HABITAT REQUIREMENTS: Drumming logs in hardwood saplings, small poles, brushy escape cover, hardwood stands for nesting and feeding, sunny openings for dusting (Pough 1951:176). Strongly associated with the aspen type, especially in the Lake States (Gullion 1972), Grouse also occur in New England woodlands in which aspens exist only as scattered trees, or are absent. Old orchards are ideal fall habitat in New England.

NESTING: Egg dates: April 1 to June 22, New York (Fall 1974:206). Clutch size: 8 to 15, typically 9 to 12. Incubation period: About 24 days. Nestling period: Less than 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Usually on dry ground in dense cover in the shelter of a fallen log, rock, root, or overhanging conifer limb near base of tree. Very often located at edge of a path or clearing and close to a source of water.

HOME RANGE: For males, the home range may be as small as 6 to 10 acres (2.4 to 4.0 ha) (Gullion 1972).

SAMPLE DENSITIES: Maximum density under optimum conditions seems to be about 1 pair per 6 to 8 acres (2.4 to 3.2 ha) (Gullion 1972).

FORAGING: Major foods: Seeds, insects, fruit, leaves, buds of birch, aspen, hazel, hophornbeam, and clay are staples in fall and winter. Substrate: Leaf litter. Techniques: Scratching and pecking, browsing. Preferred feeding habitat: Aspen stands are favorite feeding places in winter especially in the boreal forest zone (Svoboda and Gullion 1972).

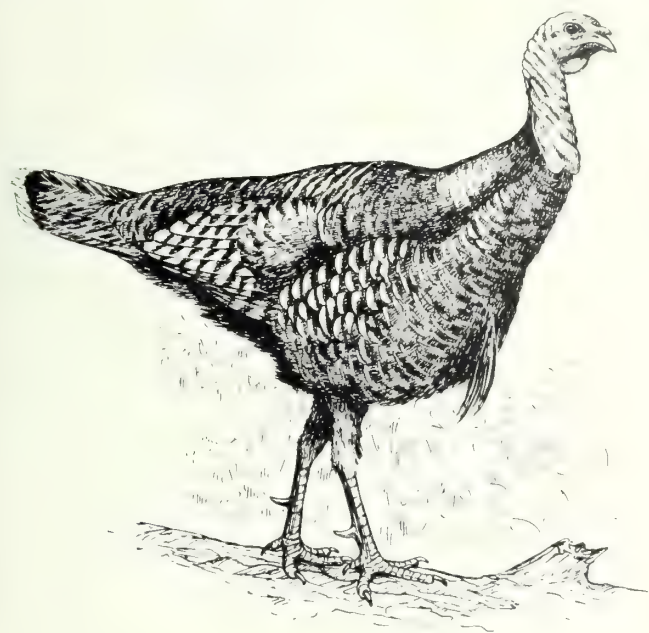
COMMENTS: Males are polygamous. In winter, birds may roost in small groups. In severely cold weather grouse burrow-roost in snow if not crusted.

KEY REFERENCES: Bent 1932, Bump et al. 1947, Gullion 1972, Svoboda and Gullion 1972.

Wild Turkey

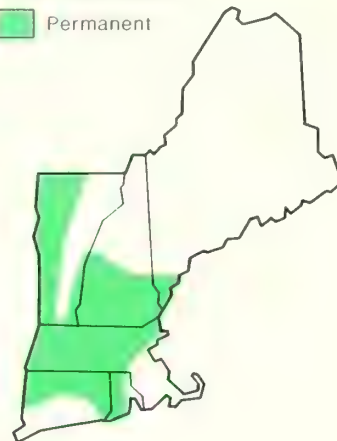
(*Meleagris gallopavo*)

O.U. No. 310.0



Range

 Permanent



GE: Breeding: Resident in parts of Vermont, New Hampshire, Maine, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Maryland, and West Virginia. Largest numbers occur in southern New York southward in the Appalachian highlands through Pennsylvania and West Virginia. Range is expanding in New England where a population was recently reestablished via trapping and transplanting. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to rare.

HABITAT: Breeding: Forests, woodland clearings, especially in hilly or mountainous regions where food is available, open fields with trees nearby for roosting and cover. Ideal habitat is a network of open, mixed forests or fields. The conifers provide roosting sites, and the hardwoods provide feeding areas. Wintering: In woodlands, flocks prefer south slopes with mast producing hardwoods and abundant springs and seeps. In New England, turkeys readily use agricultural habitats such as orchards, dairy farms, orchards, and pastures with abundant barberry or other fruiting shrubs.

SPECIAL HABITAT REQUIREMENTS: Mast-producing woodlands. Large conifers or hardwoods for roosting, open woodlands, abundant water (Schorger 1966:224-227).

NESTING: Egg dates: April 26 to July 9, New York (Bull 1974:212). Clutch size: 8 to 15, typically 10. Incubation period: 28 days. Nestling period: 1 day (precocial). Broods per year: 1, but hens renest if the first clutch is destroyed. Age at sexual maturity: Usually 1 year for females and 2 years for males. Nest site: Turkeys lay their eggs in a simple depression or dry ground, usually in dead leaves. Nests are usually under low, shrubby cover, near water, and next to a tree or stump. Hens exhibit no forest-type preference, but often nest in cut-over areas.

HOME RANGE: The annual range includes 4 or 5 square miles (1.5 to 1.9 km²) (Pough 1951:190), but seasonal ranges are smaller and often distinct from one another. Home ranges are often restricted to 100 to 200 acres (40 to 80 ha) during the winter and nesting seasons. Large movements often occur in early spring, late summer, and fall.

SAMPLE DENSITIES: 7.7 birds per square mile (3 birds/km²) on forested refuge land in West Virginia (Uhlig 1950). 15 to 20 birds per square mile (6 to 8 birds/km²) under ideal conditions (Pough 1951:189).

FORAGING: Major foods: Acorns and beechnuts are staple foods; turkeys will eat the fruits and seeds of most trees and shrubs, also fruits, flowers, and leaves of herbaceous plants, tubers, roots, and insects. Substrates:

Wild Turkey (Continued)

(*Meleagris gallopavo*)

Leaf litter, plants. Techniques: Scratching and pecking, gleaning, grazing. Preferred feeding habitat: Mast-producing woodlands during fall and winter; fields, pastures, and woodlands with rich, herbaceous ground cover during summer.

COMMENTS: A nomadic feeder—may visit feeding areas a half-mile or more apart. Males are polygamous. Elevation, topography, general location, and accessibility of forested areas may be more important to turkeys than forest types alone (Uhlig and Bailey 1952).

KEY REFERENCES: Bent 1932, Mosby and Handley 1943, Schorger 1966.

Northern Bobwhite

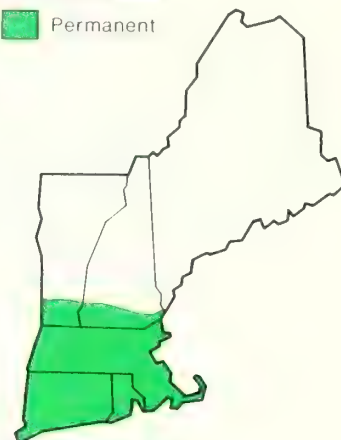
(*Colinus virginianus*)

O.U. No. 289.0



Range

 Permanent



RANGE: Breeding: Southwestern Maine, w. to South Dakota, s. to the Gulf of Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon. Birds in s. New Hampshire and Maine probably are released stock.

HABITAT: Breeding: Open pastures, meadows with abundant weedy growth, open woodlands. Favors cultivated and fallow agricultural lands with hedgerows and dense brush for cover. Avoids deep woods. Wintering: Open areas with an edge of protective vegetative cover; pastures and brushy open woods, cultivated and fallow fields.

SPECIAL HABITAT REQUIREMENTS: Edges, well-drained sandy or loamy soils, woodland (10 to 90 percent) (Rosene 1969). Dense cover within 150 feet of feeding areas essential in winter (Pough 1951:184).

REPRODUCTION: Egg dates: May 25 to September 24, New York (Bent 1932:203). Clutch size: 12 to 20, typically 14 to 16. Incubation period: 23 to 24 days. Nestling period: 1 or 2 weeks (precocial). Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site. Usually among dead or growing grasses surrounded by patches of bare ground, often along fence rows or in neglected corners of pastures within 50 feet (15 m) of a clearing. Standing vegetation is usually less than 20 inches (0.5m) high and light stems thin enough for birds to pass between (Rosene 1969:63).

TERRITORY SIZE: Approximately 1.1 acres (0.4 ha) in fallow field in Kansas (Fitch 1958). During several hundred observations, whistling males were seen no closer than 50 feet (15 m) (Rosene 1969:61).

HOME RANGE: Coveys generally remain within an area about 0.5 mile (0.8 km) in diameter (Stoddard 1931). Winter ranges are from 4 to 77 acres (1.6 to 31.2 ha) (averages 8.2 to 17.9 acres (3.3 to 7.2 ha)) on two plantations in South Carolina (Rosene 1969:88).

SAMPLE DENSITIES: Stockard (1905:149) found 16 nests in a 30-acre (12.1-ha) field of sedge in Mississippi. 5 pairs per 100 acres (40 ha) in field and edge habitat. 1.5 pairs per 100 acres (40 ha) in pine-deciduous forest and farmland in Maryland (Stewart and Robbins 1958:125).

FORAGING: Major foods: Soft herbaceous parts of plants, buds, seeds, fruits, insects. Substrates: Bare ground, litter layer of light movable material less than 2 inches (5 cm) thick. Techniques: Gleaning, scratching, pecking. Preferred feeding habitat: Cultivated fields and open areas near protective cover.

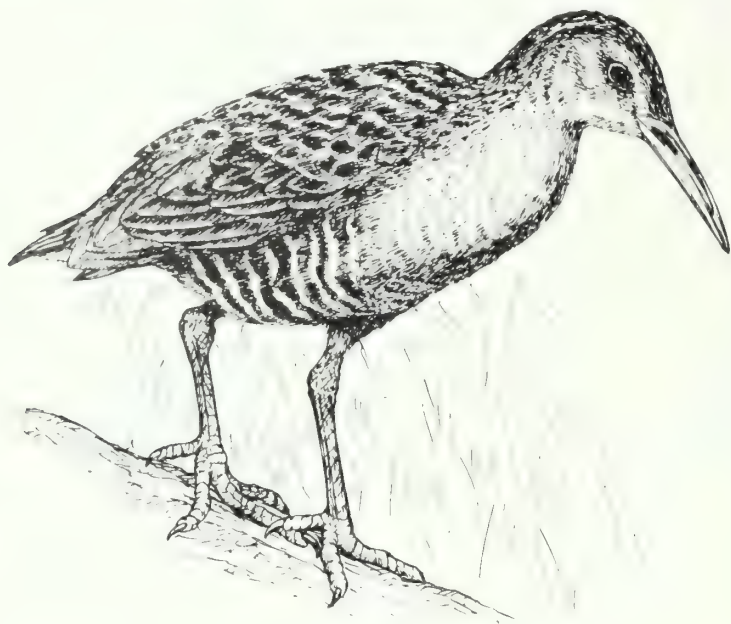
COMMENTS: Breeding pairs use wooded areas mainly for escape cover in summer but coveys of 6 to 25 individuals may remain in woods all winter if trees are scattered and canopy is open. Judd (1905 in Bent 1932:18) found that 917 stomachs contained 84 percent vegetable and 16 percent animal matter.

KEY REFERENCES: Bent 1932, Rosene 1969, Stoddard 1931.


King Rail

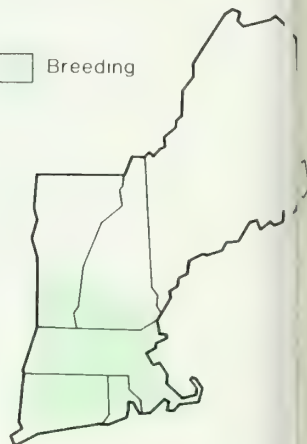
(*Rallus elegans*)

A.O.U. No. 208.0



Range

 Breeding



RANGE: Breeding: Southern New Hampshire and Vermont w. to s. Minnesota, s. to the Gulf Coast. Winter: Atlantic coast from New York.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Coastal and inland brackish to freshwater marshes with abundant vegetation (favors areas with sedges, bulrushes, and cattails), roadside ditches, and tidal rivers. Not known to breed in salt marshes. Wintering: Coastal brackish, salt, and fresh water marshes.

SPECIAL HABITAT REQUIREMENTS: Adequate vegetation for nesting and protection with fairly constant water levels throughout the breeding season (no deep flooding or drying).

NESTING: Egg dates: May 24 to July 3, New York (Bull 1974:218). Clutch size: 6 to 15, typically 10 or 11. Incubation period: 21 to 23 days. Nestling period: Less than 1 day (precocial). Broods per year: 1 (possibly 2 in southern states). Nest height: To 1.5 feet (0.5 m). Typically 0.5 to 1.5 feet (0.2 to 0.5 m). Nest site: Usually 6 to 18 inches (0.1 to 0.5 m) above water, often on a hummock among cattails, marsh grasses, rushes, or other aquatic vegetation, the stalks and leaves of which form a natural canopy. Water depth surrounding nest is usually less than 2 feet (0.6 m).

TERRITORY SIZE: Size not known. Male establishes and defends territory against King and other Rail species.

SAMPLE DENSITIES: 3 nests per 464 feet (141.5 m) of roadside ditch 30 feet (9.1 m) wide in Arkansas (Meanley 1969:49). 30 birds per 100 acres (40 ha) of inland freshwater marsh in Florida (Bateman 1977).

FORAGING: Major foods: Aquatic and terrestrial insects, amphibians, crustaceans, mollusks, seeds of marsh plants, waste grain. Substrates: Marsh vegetation, shallow water (2 or 3 inches deep (5.1 to 7.6 cm), mudflats exposed by low tide. Techniques: Probing with bill, pecking, immersing head and neck, dabbling. Preferred feeding habitat: Feeds within breeding habitat but also ranges into nearby hay and grain fields.

COMMENTS: Animal food component of 118 stomachs collected in Arkansas was 90 percent for spring and summer birds, 74 percent for fall birds, and 58 percent for winter birds (Meanley 1969). Wetland protection measures to prevent loss of habitat are important for maintaining small populations of King Rails in the Northeast.

KEY REFERENCES: Bateman 1977, Blandin 1963, Meanley 1969.


Virginia Rail

(*Rallus limicola*)

D.U. No. 212.0



Range

 Breeding



RANGE: Breeding: Nova Scotia and Quebec, s. to North Carolina, w. to California. Winter: Southern New Jersey, w. and s. Rarely n. to Massachusetts and New York.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (Massachusetts) during the breeding season.

HABITAT: Breeding: Fresh water marshes with abundant vegetation such as sedges and cattails. Occasionally found in brackish and salt marshes. Widespread breeder at lower elevations. Wintering: Mainly in tidal marshes.

SPECIAL HABITAT REQUIREMENTS: Wetlands with sedge and cattail edge.

REPRODUCTION: Egg dates: May 5 to July 15, New York (Bull 191:219). Clutch size: 6 to 13, typically 8 to 10. Incubation period: 19 days. Nestling period: Less than 1 day (social). Broods per year: 1 or 2. Nest height: To 1 foot (0.3 m), typically less than 1 foot (0.3 m). Nest site: Usually 2 to 12 inches (5.1 to 30.5 cm) above water level in marsh vegetation. Usually well anchored to plant roots and protected from above by leaves that form a canopy. Water depth near nest is typically 3 to 10 inches (7.6 to 25.4 cm).

TERRITORY SIZE: Does not seem to be territorial.

POPULATION DENSITIES: 1 bird per acre (0.4 ha) in marsh in Colorado (Zimmerman 1977:50). 1.2 pairs per ha (2.5 acres) in marsh in New York (Post and Enders 1970). 5 birds per 0.5 acre (1.2 ha) in Michigan (Berger 1951).

FORAGING: Major foods: Small fish, insects, seeds of marsh plants, berries, snails, crustaceans, worms. Substrates: Soft mud, tops and undersides of floating plants, pond debris. Techniques: Probing, gleaning. Preferred feeding habitat: Weed fields adjacent to breeding area.

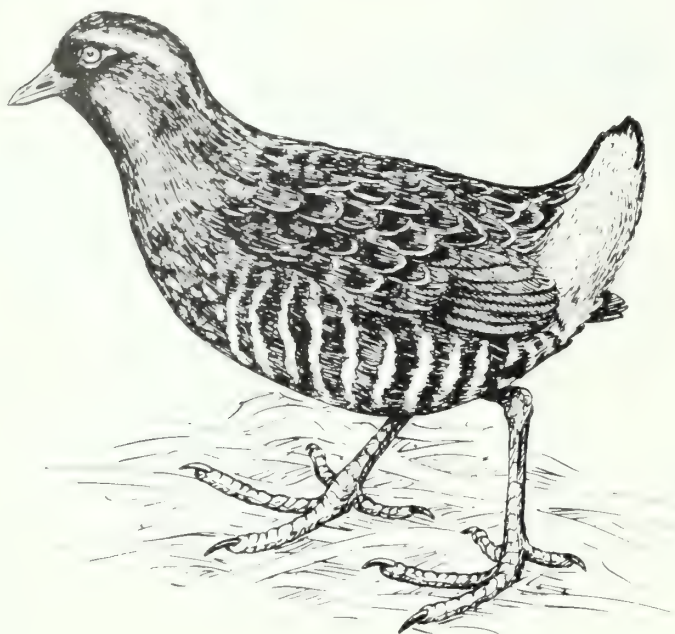
COMMENTS: Protection of existing wetlands is essential to the welfare of the Virginia Rail. Virginia Rails benefit from marsh management techniques employed for other game birds and mammals.

KEY REFERENCES: Berger 1951, Post and Enders 1970, Walkinshaw 1937, Zimmerman 1977.



Sora

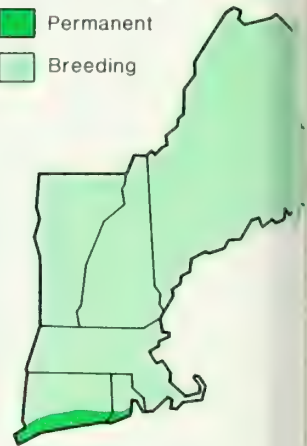
(*Porzana carolina*)

A.O.U. No. 214.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Nova Scotia and Quebec, w. to British Columbia and s. to Maryland and Ohio. Winter: Northern Florida and the Gulf Coast, s. Rarely n. to s. New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine).

HABITAT: Breeding: Marshes (favors fresh water), ponds, swamps, bogs, wet grassy meadows, sloughs having abundant and dense vegetation. Prefers sedges or cattails where mud and water are deep. Wintering: Tidal marshes.

NESTING: Egg dates: April 30 to July 17, New York (Bull 1974:220). Clutch size: 6 to 13, typically 10 to 12. Incubation period: 16 to 19 days (about 14 days (Odum 1977)). Nestling period: Less than 1 day (precocial). Broods per year: 1. Nest site: Nest is usually located on a platform of vegetation about 6 inches to more than 1 foot (15.2 to 30.5+ cm) above water level and is concealed from above by plants. Typically nests in the sedge zone of the marsh.

SAMPLE DENSITIES: Thought to be about 12 birds per acre (0.4 ha) at a reservoir in Colorado (Odum 1977). 35 nests per 107 acres (43.3 ha) in Iowa (Tanner and Hendrickson 1956). 4 pairs per 0.5 acre (0.2 ha) in cattail and sedge marsh in Michigan (Berger 1951).

FORAGING: Major foods: Aquatic and terrestrial insects (larvae and adults); cultivated grains and seeds (fall) especially those of sedge, wild rice, and bulrush; mollusks,

crustaceans. Substrates: Shallow water, mud, marsh vegetation. Techniques: Probing, gleaning. Preferred feeding habitat: Wetlands, grain fields, dense seed-producing weeds.

COMMENTS: Birds rely heavily on seeds in the fall, particularly in fresh water habitats. In brackish water areas, animals are the principal food items (Webster 1964). The Sora has been steadily decreasing in the Northeast since the turn of the century.

KEY REFERENCES: Bent 1926, Odum 1977, Tanner and Hendrickson 1956, Walkinshaw 1940, Webster 1964


Common Moorhen

(*Gallinula chloropus*)

D.U. No. 219.0



Range

 Breeding



AGE: Breeding: Western New England and c. Maine, to Minnesota, s. to South America. Winter: South Carolina, w. to California, s. to South America.

ATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Freshwater marshes, ponds, lakes, reservoirs, nearly any body of water with emergent vegetation growing in water 1 foot (0.5 m) deep or deeper (Pough 1951).

SPECIAL HABITAT REQUIREMENTS: Emergent vegetation growing in water 1 to 3 feet (0.5 to 0.9 m) deep (Krauth 1972 in Strohmeyer 1977). Requires some open water (Ell 1974:224).

REPRODUCTION: Egg dates: May 14 to July 25, New York (Bull 194:224). Clutch size: 6 to 17, typically 10 to 12. Incubation period: 21 days. Nestling period: Probably less than 1 day (precocial). Broods per year: 1 or 2. Nest height: To 2 feet (0.6 m), typically less than 1 foot (0.3 m). Nest site: Typically nests on a hummock or other clump of emergent vegetation. Occasionally nests in shrubs such as willow or alder. Nest is usually over water 1 to 3 feet deep (0.3 to 0.9 m) and is well concealed by a canopy formed from surrounding taller plants.

FEEDING: Major foods: Vegetation leaves and stems of freshwater plants, duckweed, leaves of grass and herbs, seeds and berries are staples. Animal foods include: snails, insects, and worms. Substrates: Water, surfaces of aquatic plants, mud. Techniques: Diving, dabbling, wading.

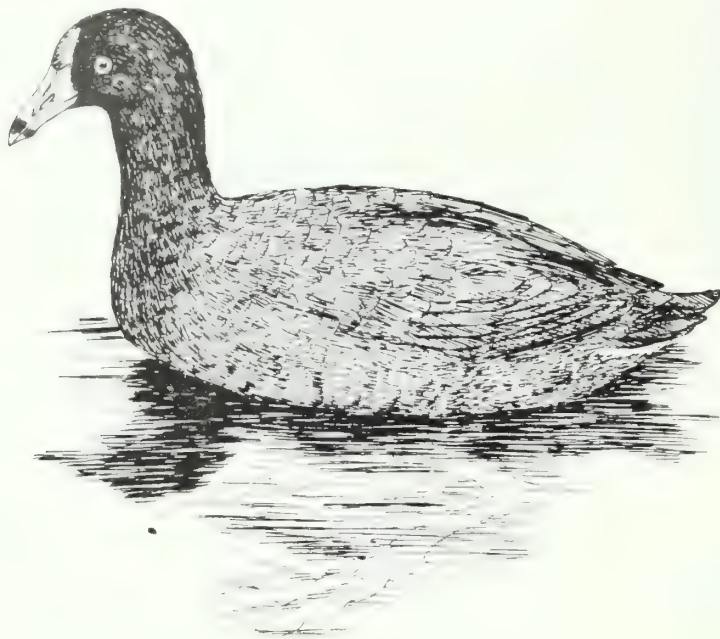
COMMENTS: Wetmore (1916) found 97 percent vegetable matter and 3 percent animal matter in 4 stomachs taken in May in Puerto Rico. Prefers the cattail zone of marshes (Allen 1939). Occurs in cattail-sedge marshes (Strohmeyer 1977) as well as *Phragmites* and *Sparganium*. Formerly Common Galinule.

KEY REFERENCES: Bent 1926, Fredrickson 1971, Strohmeyer 1977.


American Coot

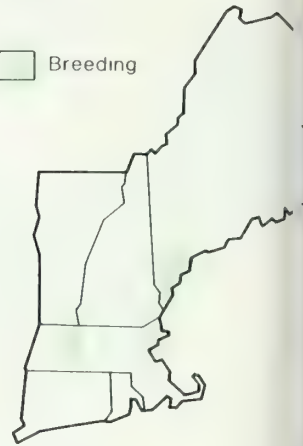
(*Fulica americana*)

A.O.U. No. 221.0



Range

 Breeding



RANGE: Breeding: New Brunswick and s. Quebec, w. to British Columbia, s. to New Jersey, Ohio, Tennessee. Winter: Southern New Jersey, Maryland, s. Illinois, w. to Arizona, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare (Massachusetts) in breeding season. Uncommon to rare at coast in winter.

HABITAT: Breeding: Freshwater marshes, ponds, wet meadows, lakes, reservoirs, sewage lagoons, marshy borders of creeks and rivers with abundant emergent vegetation. Wintering: Ice-free fresh and brackish marshes along the coast.

SPECIAL HABITAT REQUIREMENTS: Shallow water 1 to 4 feet (0.3 to 1.2 m) deep with emergent vegetation.

NESTING: Egg dates: April 25 to July 14, New York (Bull 1974:224). Clutch size: 4 to 17, typically 9 or 10. Incubation period: 23 to 24 days. Nestling period: 1 to several days (precocial). Age at first flight: Probably 7 to 8 weeks. Age at sexual maturity: Probably 1 year. Nest site: Usually floating on surface of water 1 to 4 feet (0.3 to 1.2 m) deep and anchored to surrounding emergent vegetation (often cattails or bulrushes). Coots build platforms of vegetation for resting and brood rearing, and use muskrat houses for the same purposes.

TERRITORY SIZE: Average about 1 acre (0.4 ha) for 5 pairs in California (Gullion 1953). Coots are strongly territorial during the breeding season, defending nest against both coots and other marsh birds.

SAMPLE DENSITIES: 432 pairs per mile (166 pairs/km²) under ideal conditions in the prairies of North Dakota (Stewart and Kantrud 1972). 1 nest per 0.54 acre (0.2 ha) in Iowa (Friley et al. 1938).

FORAGING: Major foods: Underwater plants are staple as well as algae, grass shoots, grains, aquatic insects. Bulk of diet is vegetable matter but takes fish, tadpoles, worms, and crustaceans. Substrate: Shallow water. Techniques: Diving, grazing, dabbling. Preferred feeding habitat: In winter, coots often graze on lawns, golf courses, pastures, and cultivated fields.

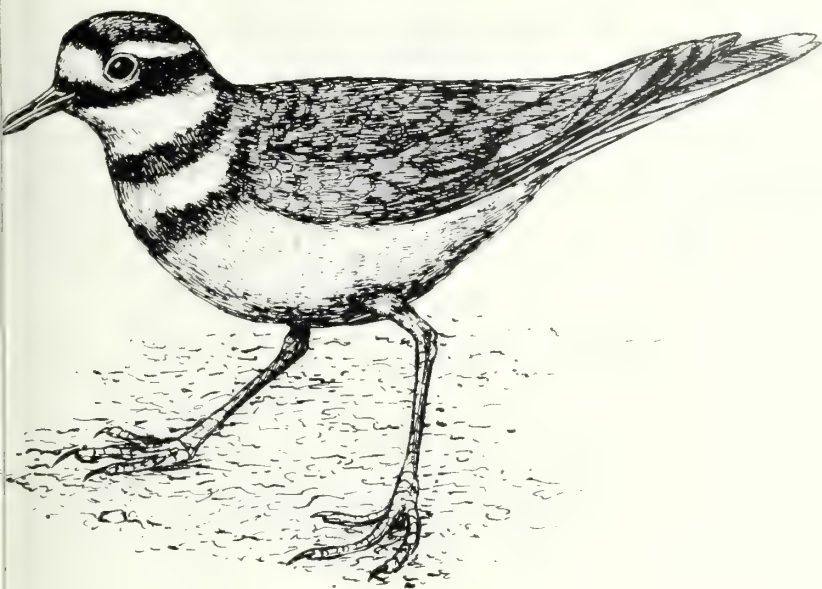
COMMENTS: Highest breeding densities of coots in Iowa were noted where 50 percent of marsh was open water and remaining 50 percent was emergent vegetation (Weller and Fredrickson 1973).

KEY REFERENCES: Bent 1926, Fredrickson 1970, Gullion 1953, Stewart and Kantrud 1972.

Killdeer

(*Charadrius vociferus*)

D.U. No. 273.0



Range

- Permanent
- Breeding



RANGE: Breeding: Southern Canada, w. to British Columbia, s. to South America. Winter: Southern New England and New York, s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in breeding season. Common along coast in winter.

HABITAT: Breeding: Heavily grazed meadows, edges of pasture ponds, dry uplands. Often close to human habitation such as on lawns, golf courses, cemeteries, unused parking lots and driveways, airports, cultivated fields, waste places. Wintering: Plowed or sparsely vegetated moist fields. Coastal flats and beaches, river and marsh shores that are free of ice.

SPECIAL HABITAT REQUIREMENTS: Open fields or waste areas with closely cropped or sparse vegetation.

REPRODUCTION: Egg dates: April 3 to July 4, New York (Bull 1929:239). Clutch size: 3 to 5, typically 4. Incubation period: 24 to 29 days. Nestling period: Less than 1 day (prosocial). Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: Eggs are deposited on bare, often rocky ground in a depression hollowed out by the female. Often a few small stones, wood chips, or other debris is placed inside. Pastures, meadows, and cultivated fields are favorite sites.

POPULATION DENSITIES: 24 pairs per square mile (9 birds/km²) (maximum density) in North Dakota (Stewart and Kanwisher 1972). 3.9 pairs per 100 acres (40 ha) in plowed field in wheat field in Maryland (Stewart and Robbins 1995:136).

FORAGING: Major foods: Insects—especially beetles and grasshoppers; centipedes, spiders, worms, snails, crayfish, weed seeds. Substrates: Bare soil, short grasses. Techniques: Robin-like running and pausing, gleaning.

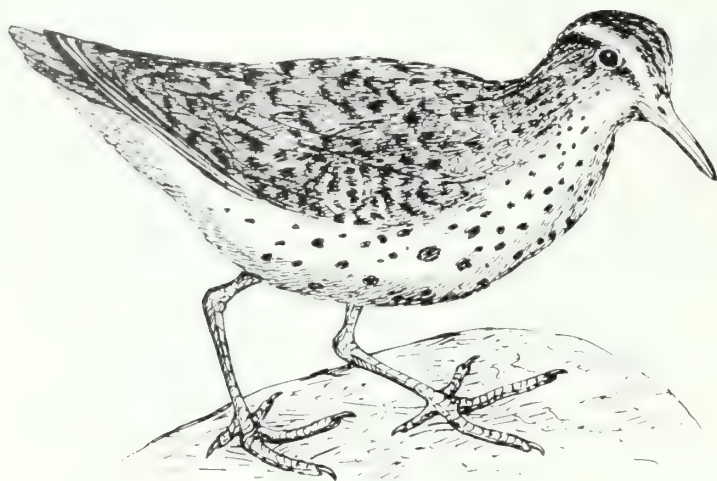
COMMENTS: Killdeer are solitary feeders. They spread out over an area rather than feed in compact groups like sandpipers. Habitat trends: increasing in Maine, Ohio; decreasing in Massachusetts, New Hampshire, Rhode Island; static in Connecticut, Delaware, and Vermont; unknown in New Jersey (Jurek and Leach 1977).

KEY REFERENCES: Bent 1929, Nickell 1943, Pough 1951.

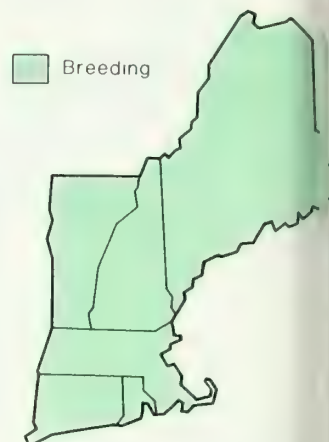
Spotted Sandpiper

Actitis macularia

A.O.U. No. 263.0



Range



RANGE: Breeding: Newfoundland, Quebec w. to Mackenzie District, Northwest Territory, and Alaska, s. to South Carolina, Texas, and New Mexico. Winter: South Carolina, the Gulf States, s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon and widespread.

HABITAT: Breeding: Breeds in vicinity of fresh water often along edges of ponds, lakes, rivers or far from water in dry fields, pastures, and weedy shoulders of roads. Also uses coastal beaches and dunes. Prefers open terrain.

NESTING: Egg dates: May 6 to July 26, New York (Bull 1974:251). Clutch size: 3 to 5, typically 4. Incubation period: 20 to 24 days. Nestling period: Less than 1 day (precocial). Age at first flight: 15 to 16 days. Age at sexual maturity: 1 year. Nest site: Nests are solitary or in loose colonies. Eggs are laid in a depression in the ground that is lined with grass. Often under shrubs or weeds or in tall grass up to 30 inches high (76.2 cm).

TERRITORY SIZE: Little or no defended area.

SAMPLE DENSITIES: 43 pairs per 17.6 acres (7.1 ha) of dry meadow-rocky shore-sandy beach habitat in Michigan (Miller and Miller 1948).

FORAGING: Major foods: Insects, especially grasshoppers and crickets, small fish (occasionally), and crustaceans. Substrates: Mud, wet and dry sand, short grasses.

Techniques: Walking slowly and gleaning, occasional catching insects on the wing, swimming and diving.

COMMENTS: Pair bond is both monogamous and polygamous. Females often polyandrous (Hays 1972). Spotted Sandpiper numbers are static throughout most of the Northeast but seem to be decreasing in Massachusetts (Jurek and Leach 1977).

KEY REFERENCES: Bent 1929, Hays 1972, Miller and Miller 1948.

Upland Sandpiper

(*Tringa longicauda*)

A.U. No. 261.0



Range



EGGING: Breeding: Central Maine (few), w. to Alaska, s. to Virginia, Illinois, Oklahoma. Winter: South America.

REPRODUCTIVE ABUNDANCE IN NEW ENGLAND: Uncommon (rare) to rare (Massachusetts, Vermont).

HABITAT: Breeding: Wide open pastures or grassy fields, hayfields of alfalfa or clover; occasionally opening in forest.

REPRODUCTION: Egg dates: April 23 to June 15, New York (Bull 1925:254). Clutch size: 4 to 5, typically 4. Incubation period: 21 to 24 days. Nestling period: Less than 1 day (incubation period). Age at first flight: About 30 to 31 days. Eggs per year: 1. Age at sexual maturity: 1 year. Nest site: Well hidden in a depression in grass covered by low vegetation. Usually nests in loosely spaced colonies.

TERRITORY SIZE: Two pairs had territories of 20 to 30 acres (8.1 to 12.1 ha) each in grassland in Wisconsin (Wiens 1991).

HOME RANGE: For a nesting male and female, the mean distance travelled from nest was 241 m (263.6 yards) and 195 m (213.6 yards), respectively. The female home range was 8 ha (19.8 acres), the male home range was 86 ha (212.4 acres) (Ailes and Toepfer 1977).

POPULATION DENSITIES: 1 nest per 1.5 to 15 acres (0.6 to 6.1 ha) (Harrison 1975:70). 20 pairs per square mile (8 pairs/km²) maximum density in North Dakota (Stewart and

Kantrud 1972). 7 nests were found in a 17-acre (6.9 ha) timothy field (Buss and Hawkins 1939).

FORAGING: Major foods: Insects — especially grasshoppers and crickets, waste grains and seeds of grasses and weeds. Animal 97 percent, vegetable 3 percent (McAtee 1912 in Bent 1929). Substrate: Grasses. Techniques: Robin-like alternate running and pausing.

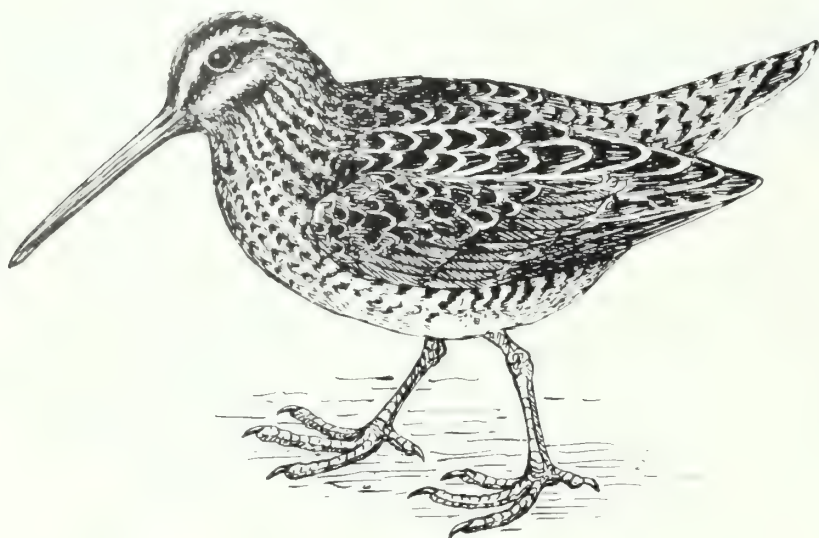
COMMENTS: Logging and small-scale farming have created good habitat for the Upland Sandpiper in the Northeast, enabling the bird to expand its range. Hayfields and old pastures are favored nesting habitat in New York State (Bull 1974:254). Extensive plowing and cultivating has destroyed much habitat in the prairies of the Midwest. Birds are decreasing in New Hampshire and Massachusetts where they are rare, and in Maryland, where uncommon (Jurek and Leach 1977).

KEY REFERENCES: Bent 1929, Buss and Hawkins 1939.



Common Snipe

(*Gallinago gallinago*)

A.O.U. No. 230.0



Range

-  Breeding
-  Winter



RANGE: Breeding: Most of Canada, s. to n. New England, Pennsylvania, and n. New Jersey. Winter: Coastal New England to Virginia and inland to California, s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (c. and w. Maine) to uncommon (Vermont) in breeding season.

HABITAT: Breeding: Marshes with short vegetation, sedge bogs, alder and willow swamps, pond margins and lowlands associated with brooks and rivers where soils are mucky and the vegetation is sparse, wet meadows. Wintering: Near coast at small open creeks, springs and streams, marshes, fallow fields, cow pastures.

SPECIAL HABITAT REQUIREMENTS: Moist organic soils. Low scanty vegetation for nest and brood cover. Bogs, swamps. Large open spaces for courtship activities.

NESTING: Egg dates: April 20 to June 16, New York (Bull 1974:242). Clutch size: 3 to 5, typically 4. Incubation period: 18 to 20 days. Nestling period: Less than 1 day (precocial). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Nest is concealed among grasses or other vegetation on dry ground, sometimes on a tussock of grass or sedge.

TERRITORY SIZE: Unknown. Male selects and defends an area against other snipes. Size decreases as incubation advances. Defense ceases after chicks hatch.

SAMPLE DENSITIES: Breeding: Up to 17 pairs per 100 ha (247 acres) on peatland in Newfoundland (Tuck 1972).

Spring: 11.6 birds per 100 acres (40 ha) in Oregon (Fogarty and Arnold 1977). Winter: 275 birds per 100 acres (40 ha) in Florida (Fogarty and Arnold 1977).

FORAGING: Major foods: Larvae of aquatic insects (about 50 percent of diet), earthworms (staple), snails, small crustaceans, seeds of marsh plants. Substrates: Marshes, shallow water, dry and wet grasses, surfaces of marsh plants. Techniques: Probing, gleaning. Preferred feeding habitat: Winter-marshes where taller vegetation is cut back exposing bare mud.

COMMENTS: Males and females are promiscuous. Erickson (1941) found that animal matter accounted for 61 percent of the contents of 76 stomachs. White and Harris (1966) and Sperry (1940) found animal matter in more than 80 percent of the diet.

KEY REFERENCES: Bent 1927, Erickson 1941, Fogarty and Arnold 1977, Tuck 1972, White and Harris 1966.


American Woodcock

(*Colaptes auratus*)

U. No. 228.0



Range

 Breeding



RANGE: Breeding: Southern Newfoundland, s. Quebec, s. e. Manitoba, s. to Florida and Texas. Winter: northern New Jersey and the Ohio Valley, s. to c. Florida and Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (e) to uncommon. Rare in winter along coast.

HABITAT: Breeding: Moist woodlands in early stages of succession, swamps, stream banks, bogs, rich bottomlands, often in thickets of alder, willow or maple, brushy areas of woods, dry open woods and fields. Wintering: concentrate along rivers and streams.

LOCAL HABITAT REQUIREMENTS: Fertile, moist soil that retains earthworms. Fields or small forest openings for courtship activities and nocturnal roosting. Dense grassy swales for diurnal cover.

REPRODUCTION: Egg dates: March 24 to June 17, New York (Bull 1940). Clutch size: 3 to 5, typically 4. Incubation period: 20 to 21 days. Nestling period: Several days (pre-emptive). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On forest floor or abandoned field in a slight depression lined with a few dead leaves. Usually placed within 50 yards (45.7 m) of an edge. Hidden in a variety of cover from grasses to young or middle-aged woods of light to medium density (Owen 1977).

TERRITORY SIZE: Females do not defend nests. The singing ground of the male may range in size from about 0.25 acre (0.1 ha) to more than 100 acres (40 ha) (Owen 1977).

SAMPLE DENSITIES: 4 to 7 males per mile (1.6 km) in New Hampshire and Maine singing ground surveys in 1971 and 1972 (Owen 1977). 5.6 territorial males per 100 acres (40 ha) in brushy abandoned farmland in Maryland. 1.5 territorial males per 100 acres (40 ha) in cut and burned woodland in Maryland (Stewart and Robbins 1958:139).

FORAGING: Major foods: Earthworms accounted for 50 to 90 percent of diet (Sperry 1940). Larvae of beetles, flies and other insects form the balance. Leaves, seeds, and fruits are occasionally taken. Substrates: Soft earth, mud, leaf litter, dry grasses. Techniques: Probing, gleaning. Preferred feeding habitat: Open pastures, cultivated fields, stream banks.

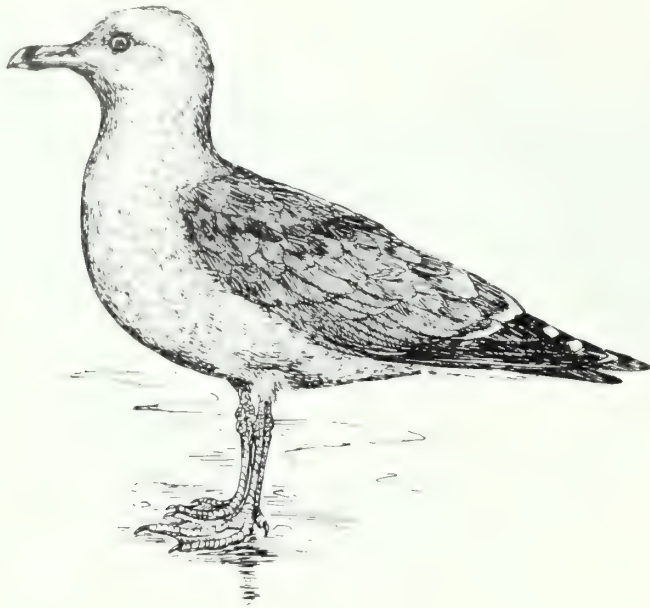
COMMENTS: Males typically have polygynous mating habits. Courtship takes place only where there are scattered woody plants 1 to 2 feet (0.3 to 0.6 m) high, in early succession (Sheldon 1967:64). Estimated carrying capacity under best breeding conditions is about 1 pair per 5.5 to 6.0 acres (2.2 to 2.4 ha) (Mendall and Aldous 1943).

KEY REFERENCES: Bent 1927, 1929, Mendall and Aldous 1943, Owen 1977, Sheldon 1967.



Ring-billed Gull

(*Larus delawarensis*)

A.O.U. No. 054.0



Range

-  Breeding
-  Winter



RANGE: Breeding: Alaska and Labrador s. to the Great Lakes and California. Winter: Atlantic coast from Nova Scotia to Gulf of Mexico and Mississippi River and major tributaries.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common locally.

HABITAT: Breeding: Lakes and rivers, open beaches, mudflats and harbors. Wintering: near salt water.

NESTING: Egg dates: June 20 to 30, Labrador (Bent 1921). Clutch size: 2 to 4 usually 3. Incubation period: 21 days. Broods per year: 1. Nest height: On the ground, occasionally in low trees. Nest site: Often on lake islands.

FORAGING: Major foods: insects, worms, grubs, and sometimes bird eggs and mice; they also scavenge.

TERRITORY SIZE: Colonial nester 85,000 pairs nest on an island in Lake Ontario (Bull and Farrand 1977:447).

KEY REFERENCES: Bent 1921, Burleigh 1958.

Ring-billed Gull

(*Larus argentatus*)

D.O.U. No. 051.0



Range

- Breeding
- Winter



RANGE: Breeding: Northern North American and along Atlantic coast as far s. as North Carolina. Winter: along the Atlantic and Gulf Coasts.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Mainly on islands in lakes, rivers, estuaries, also on coastal beaches. Wintering: same breeding habitat except where bodies of water freeze.

REPRODUCTION: Egg dates: May 4 to August 8. Clutch size: 2 to typically 3. Incubation period: 25 to 28 days. Broods per year: 1. Nest site: On the ground, also on cliff ledges, occasionally in trees.

FEEDING: Major foods: Fish and shell fish, offal from fishing boats and fish processing plants. They also forage along shorelines and at garbage dumps. Substrates: Surface and shoreline of bodies of water, land.

REMARKS: In recent years it has become abundant, probably due to the amount of food available at garbage dumps, and has extended its range southward along the Atlantic Coast, often to the detriment of colonial birds such as Terns and Laughing Gulls (Bull and Farrand 1974:445).



Great Black-backed Gull

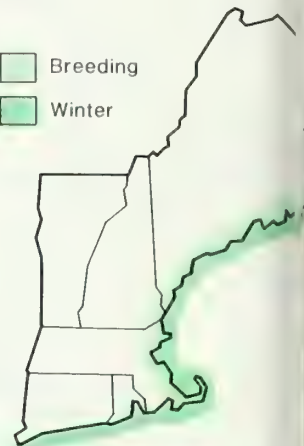
(*Larus marinus*)

A.O.U. No. 047.0



Range

-  Breeding
-  Winter



RANGE: Breeding: From Labrador to New York along the North American East coast. Winter: As far s. as North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Cliffs and on islands in freshwater lakes. Wintering: Usually rivers and freshwater lakes near the coast and coastal islands.

NESTING: Egg dates: May through June. Clutch size: 3, sometimes 2. Incubation period: 27 days. Nestling period: 42 to 56 days. Broods per year: 1. Nest height: On the ground on coastal islands or on cliff ledges.

TERRITORY SIZE: Nests may be solitary or in colonies of various sizes.

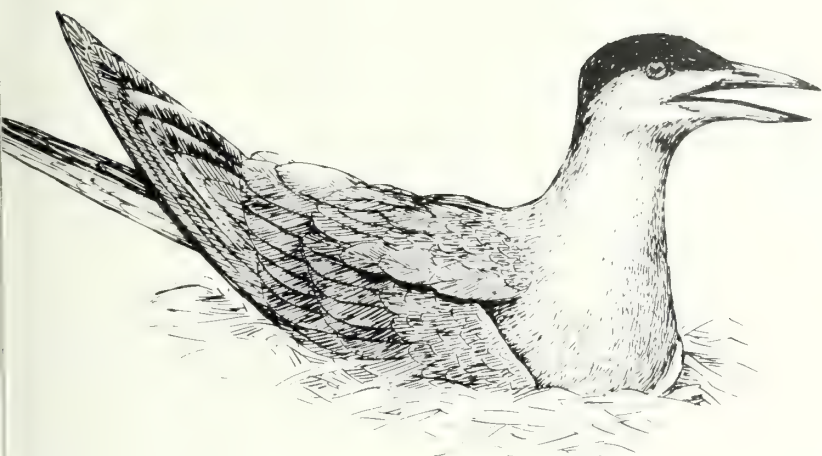
FORAGING: Major foods: Eggs and young of seabirds, carrion, and garbage from human dumps.

KEY REFERENCES: Godfrey 1979.


Common Tern

(*Sterna hirundo*)

D.U. No. 070.0



Range

 Breeding



DISTRIBUTION: Breeding: Alberta s. to Wisconsin and e. to Labrador; s. generally along the coast to Louisiana. Winter: North Carolina s. to the Straits of Magellan.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant locally.

HABITAT: Breeding: Gravelly and sandy beaches, grassy lands, on rocky shores of islands (Harrison 1975:80). Winter: Coasts from southern limit of breeding range (on Atlantic coast to South Carolina).

REPRODUCTION: Egg dates: May through July. Clutch size: 2 or usually 3. Incubation period: 24 to 26 days. Nestling period: 3 to 4 days. Broods per year: 1. Nest site: Often a wet hollow in sand, shells, or pebbles (Harrison 1975:80).

NESTING: Nest in loose colonies.

FEEDING: Major foods: Small fish. Substrates: Water surface. Techniques: Diving from air to water surface.

REFERENCES: Godfrey 1979, Harrison 1975.


Black Tern

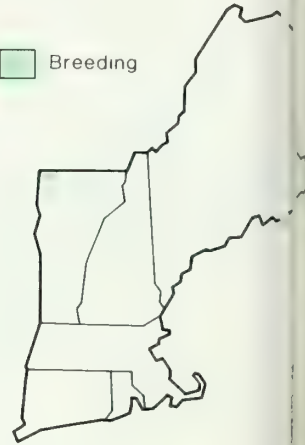
(*Chlidonias niger*)

A.O.U. No. 077.0



Range

 Breeding



RANGE: Breeding: Southern Canada s. to Pennsylvania, into w. New York and Maine. Winter: Generally s. of the United States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Coastal and inland marshes, wet meadows.

NESTING: Egg dates: May through July. Clutch size: 3. Incubation period: 21 to 24 days. Nestling period: 2 to 3 days. Broods per year: 1. Nest site: Often on islands of rotting, floating vegetation. Eggs are often wet (Harrison 1975:78).

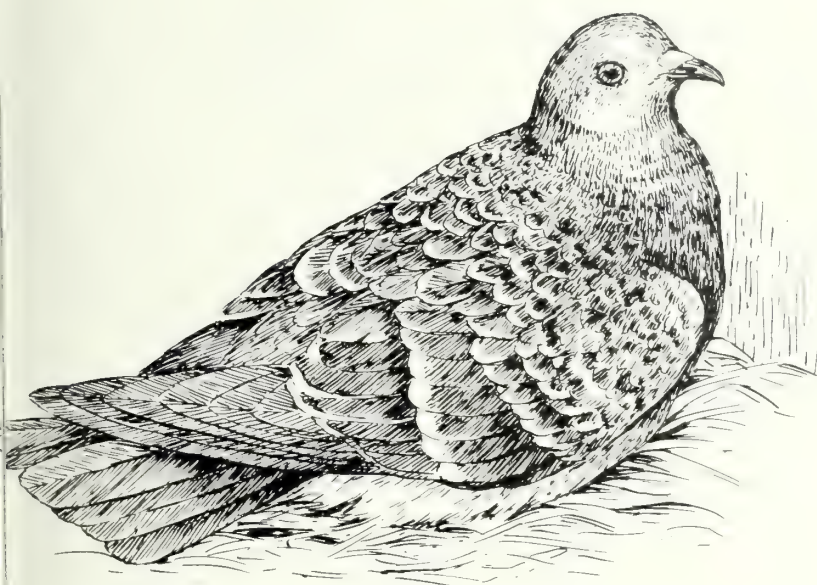
FORAGING: Major foods: Insects, fish, and small crustaceans. Substrates: Over grasses and water. Techniques: Hawking.

KEY REFERENCES: Burleigh 1958, Harrison 1975.


Rock Dove

(*Columba livia*)

O.U. No. 313.1



Range

 Permanent



RANGE: Breeding: Throughout temperate North America. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Feral birds are found in open country, sometimes near cliffs and ledges that have roosting sites, but are more common near human habitations, especially cities and farms. Wintering: Same as breeding habitat.

REPRODUCTION: Egg dates: Throughout the year (Bull 1914:316). Clutch size: 1 to 2, typically 2. Incubation period: 17 to 19 days. Nestling period: 21 to 28 days. Brood per year: 2 or 3. Age at sexual maturity: 1 year. Nest site: Usually on or in buildings or bridges or other man-made structures in semi-dark cavities. Rock Doves nest singly or in colonies.

FEEDING: Major foods: Seeds of weeds and grasses, bread crumbs, and other human handouts. Substrates: Pavement, sparsely vegetated ground. Techniques: Gleaning. Preferred feeding habitat: Sidewalks and parking lots in cities, city parks, cultivated fields, and lawns.

REMARKS: Rock Doves prefer to roost in groups in areas that are sunny and sheltered from winds. Believed to be long-lived.

REFERENCES: Forbush 1929, Goodwin 1977.



Mourning Dove

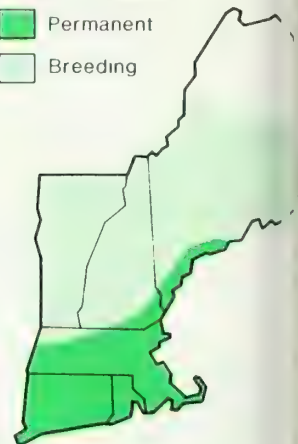
(*Zenaida macroura*)

A.O.U. No. 316.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Central Maine, New Hampshire, Vermont and New York, w. to British Columbia, s. to the Bahamas and Mexico. Winter: Southern Maine, New Hampshire and Vermont, w. to Oregon, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Open mixed woodlands and woodland edges, evergreen plantations, orchards and farmlands, suburbs, cities. Avoids dense forests and high elevations (mountains). Birds nest most frequently in agricultural and residential areas. Wintering: Similar to breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Open land with bare ground that produces adequate food (seeds).

NESTING: Egg dates: March 9 to September 28, New York (Bull 1974:320). Clutch size: 1 to 3, typically 2. Incubation period: 13 to 14 days. Nestling period: 12 to 14 days. Broods per year: 2 or more (as many as 6 clutches per season in temperate areas (Keeler 1977)). Age at sexual maturity: 1 year. Nest height: to 50 feet (15.2 m), typically 10 to 25 feet (3.0 to 7.6 m). Nest site: Often in a coniferous tree. Also in tangles of shrubs or vines. Occasionally uses old nest of other bird to support its twig platform. Nest is typically placed on a horizontal limb. Solitary or loosely colonial. DeGraaf (1975:29) found coniferous vegetation 0 to 35 feet (10.7 m) high important to Mourning Dove occurrence.

SAMPLE DENSITIES: Relative densities of breeding Mourning Doves based on the mean number heard per 20-minute (32 km) survey route: 0 to 9.9 birds—Maine, New Hampshire, Vermont, w. Pennsylvania, e. Ohio, West Virginia (Keeler 1977); 10.0 to 29.9 birds—Massachusetts, Rhode Island, Connecticut, New Jersey, e. Pennsylvania, Maryland (Keeler 1977); 30.0 to 59.9 birds—w. Virginia (Keeler 1977). 76 pairs per square mile (29 pairs/km²) favorable habitat in North Dakota (Stewart and Korte 1972).

FORAGING: Major foods: Weed seeds and waste grain from agriculture, occasionally takes small snails. Substrate: Open, bare ground; short grasses. Techniques: Watch and ground gleaning. Preferred feeding habitat: Cultivated fields.

COMMENTS: Pair bond is usually life-long monogamous. Birds generally increase their range and numbers in areas with secondary growth, cultivated fields and pastures (Goodwin 1977:206).

KEY REFERENCES: Goodwin 1977, Hanson and Korte 1962, Keeler 1977, Lehner 1965.

Black-billed Cuckoo

(*Coccyzus erythrophthalmus*)

U. No. 388.0



Range



DISTRIBUTION: Breeding: Prince Edward Island, w. to se. Atlantic, s. to South Carolina. Winter: nw. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Brushy pastures, shrubby hedgerows at edges of fields, dry, open upland woods and swamps.

SPECIAL HABITAT REQUIREMENTS: Low, dense, shrubby vegetation.

REPRODUCTION: Egg dates: May 20 to August 28, New York (1974:325). Clutch size: 2 to 5, typically 2 to 4. Incubation period: 14 days. Nestling period: 7 to 9 days (perch on branches, unable to fly). Age at first flight: Unknown. Age at sexual maturity: 1 year. Nest height: 2 to 20 feet (0.6 to 6.1 m), typically 4 to 6 feet (1.2 to 1.8 m). Nest site: Usually low in shrub or on branch of deciduous or coniferous tree, well concealed among the leaves.

FORAGING: Major foods: Caterpillars (staple); also eats beetles, grasshoppers, crickets, and other insects; is fond of fleshy fruits. Substrates: Upper and lower leaf surfaces. Technique: Leaf gleaning.

COMMENTS: The feeding habits of the Yellow-billed and Black-billed Cuckoos appear to be similar. Black-billed Cuckoos seem to use extensive woodlands more than Yellow-billed Cuckoos do (Pough 1949:5).

KEY REFERENCES: Bent 1940, Miller 1934, Spencer 1943.

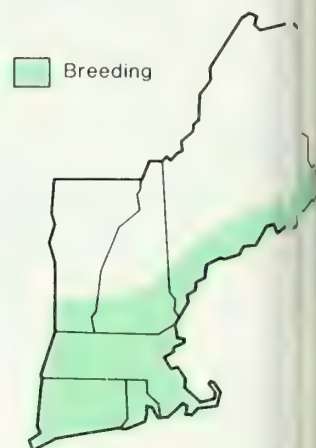
Yellow-billed Cuckoo

(*Coccyzus americanus*)

A.O.U. No. 387.0



Range



RANGE: Breeding: New Brunswick, w. to British Columbia, s. to the Florida Keys, Gulf Coast, and Mexico. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Open woods, overgrown weedy fields, roadsides, abandoned orchards, streambanks with dense thickets, brushy pastures with small trees and vines. Seldom seen at high elevations.

SPECIAL HABITAT REQUIREMENTS: Low, dense, shrubby vegetation.

NESTING: Egg dates: May 26 to August 19, New York (Bull 1974:324). Clutch size: 1 to 5, typically 3 or 4. Incubation period: About 14 days. Nestling period: 7 to 9 days (young perch on branches, unable to fly). Age at first flight: Unknown. Broods per year: Probably 1. Age at sexual maturity: 1 year. Nest height: 2 to 20 feet (0.6 to 6.1 m), typically 4 to 10 feet (1.2 to 3.0 m). Nest site: Prefers to nest in thick bushes overgrown with grape vines or in trees on horizontal limbs. Nest is usually well concealed by surrounding foliage.

SAMPLE DENSITIES: 8 territorial males per 100 acres (40 ha) in upland oak forest in Maryland. 6 territorial males per 100 acres (40 ha) in floodplain forest in Maryland. 4 territorial males per 100 acres (40 ha) in hedgerows, active and abandoned farmland in Maryland (Stewart and Robbins 1958:177).

FORAGING: Major foods: Caterpillars (staple) and insects; many kinds of fruits such as grapes, mulberries and elderberries. Substrates: Upper and lower leaf surfaces. Technique: Leaf gleaning.

COMMENTS: Frequently consumes larvae of gypsy tent caterpillar, and fall webworm. Parasitism is common practice as it is in the European Cuckoo.

KEY REFERENCES: Bent 1940, Preble 1957.

Common Barn-Owl

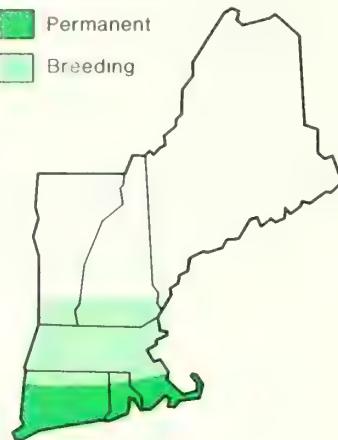
(*to alba*)

D.U. No. 365.0



Range

- Permanent
- Breeding



GE: Breeding: Mainly coastal s. New England, w. to Washington, D.C. s. Winter: Same as breeding range except that many of the northern birds migrate s. for the winter.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and local in New England (Vermont, Massachusetts). Rare in winter.

HABITAT: Breeding: Almost anywhere in open country but prefers vicinity of farms and villages. Avoids woodlands and higher elevations. Wintering: Same as breeding habitat.

NESTING HABITAT REQUIREMENTS: Abundant supply of roosts for food. Barns, silos, deserted buildings, cavities in old buildings, covered duck blinds for nesting.

REPRODUCTION: Egg dates: February to December. Peak: April to June, New York (Bull 1974:328). Clutch size: 3 to 11, usually 5 to 7. Incubation period: 32 to 34 days (Harrison 1975). Nestling period: 50 to 60 days. Broods per year: 1 or 2. Double-brooded in s. New York (Bull 1974:328). Age at sexual maturity: 1 year. Nest site: barns, abandoned buildings, silos, tree cavities, church steeples, and artificial nest sites such as bird houses, bat houses, and barrels. Also nests in burrows in cliffs or banks.

FEEDING: Major foods: Rodents (especially mice) are taken; also takes other small mammals and occasionally small birds. Substrates: Meadow grasses. Techniques: Diving and grasping, quartering low (a few meters above ground). Preferred feeding habitat: Marshes,

meadows, fields, barnyards, brushy areas, garbage dumps that attract rodents.

COMMENTS: Birds are nocturnal, roosting by day and hunting by night, hence, they are seldom observed even in thickly settled towns and cities. Barn-Owls have been observed roosting in cedar groves (Georgia) and pine plantations (Michigan). Breeding is irregular, depending on availability of food. Wallace (1948) in Michigan found that 80 to 90 percent of diet consisted of meadow mice (*Microtus*).

KEY REFERENCES: Bent 1938, Stewart 1952, Wallace 1948.

Eastern Screech-Owl

(*Otus asio*)

A.O.U. No. 373.0



Range

 Permanent



RANGE: Breeding: New Brunswick, w. to s. Alaska, s. to the Florida Keys and c. Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Massachusetts) to rare (Maine).

HABITAT: Breeding: Shade trees in towns, orchards, small woodlots, and open woodlands, Wintering: Same as building habitat.

SPECIAL HABITAT REQUIREMENTS: Cavities for nesting and roosting in trees with a minimum d.b.h. of 12 inches (30.5 cm) (Thomas et al. 1979).

NESTING: Egg dates: March 23 to May 11, New York (Bull 1974:329). Clutch size: 3 to 7, typically 4 or 5. Incubation period: 21 to 30 days. Nestling period: About 30 days. Broods per year: 1. Age at sexual Maturity: 1 year (a small percentage breed at 2 years of age). Nest height: 5 to 50 feet (1.5 to 15.2 m), typically 5 to 30 feet (1.5 to 9.1 m). Nest site: Natural cavities and abandoned woodpecker holes, especially those of the Flicker and Pileated Woodpecker. Cavities are also used for roosting and caching food.

TERRITORY SIZE: Variable. Adjacent territories are usually separated by a nondefended area (Burton 1973:101).

SAMPLE DENSITIES: 1 pair per 2.5 square miles (1 pair/km²) in Michigan (Craighead and Craighead 1969:215). 1 pair per 4 square miles (1 pair/10.4 km²) in Wyoming (Craighead and Craighead 1969:215).

FORAGING: Major foods: Rodents (especially meadow mice) and insects are staples; crayfish, snails, reptiles, amphibians, birds, and fish are also taken. Substrates: Forest floor, meadow grasses. Techniques: Swallowing and pouncing. Preferred feeding habitat: Grassy openings among widely spaced trees, open fields, meadows, or, in New England, along wooded field margins and streams.

COMMENTS: Nocturnal feeders. Cavities and nest boxes are used by the owls during winter months as feeding stations (food caches). The birds are opportunistic predators, generally consuming animal forms most readily available. May have historically occupied most of northern New England, now rarely found in southern New Hampshire (C. Anderson, personal communication).

KEY REFERENCES: Bent 1938, Van Camp and Henny 1961, Earhart and Johnson 1970.

Great Horned Owl

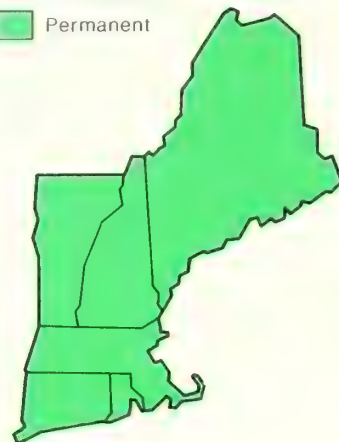
(*Bubo virginianus*)

U. No. 375.0



Range

 Permanent



RE: Breeding: Northern tree limit in Canada, s. to s. America. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common in common.

HABITAT: Breeding: Deep woods remote from populated areas, large farm woodlots, often in deep swamps near a stream or woodland pond. Mixed countryside of fields and fields. Wintering: Same as breeding habitat.

LOCAL HABITAT REQUIREMENTS: Large abandoned nests or large cavities for nesting.

REPRODUCTION: Egg dates: January 28 to April 18, New York (1974:331). Clutch size: 1 to 3, typically 2. Incubation period: 28 to 35 days (various reports of 28, 30, and 35 days). Nestling period: 40 to 45 days. Broods per year: 1. Age at sexual maturity: 2 years (about 25 percent mature when 1 year old). Nest height: 30 to 70 feet (1.1 to 2.1 m). Nest site: Commonly uses the old nest of a large bird such as heron, crow, or hawk. Also nests in large natural cavities in trees and on ledges.

POPULATION DENSITIES: 1 pair per 5.3 square miles (1 pair/7 km²) in Michigan (Craighead and Craighead 1969:214). 1 pair per 3 square miles (1 pair/7.8 km²) in New York (Craighead and Craighead 1969:215). 1 pair per 1 square mile (1 pair/2.8 km²) in Kansas. Optimal habitat probably supports from 1 to 3 pairs per square mile (0.4 to 1 pair/km²) (Baumgartner 1939). 1 pair per 4.4 square miles (1 pair/11.4 km²) in deciduous forest and in New York (Hagar 1957).

FORAGING: Major foods: Lagomorphs and rodents are staple foods; other prey includes birds, small carnivorous mammals, reptiles. Substrate: Forest floor. Techniques: Silent approach to prey via silent, direct, rapid flight, swooping, and pouncing. Preferred feeding habitat: Sometimes leaves woodlands to hunt over meadows and salt marshes.

COMMENTS: Crepuscular hunter. Extensive wooded areas with mature trees are preferred over small woodlots with second-growth trees. Birds may have become more tolerant of human activity and occasionally are seen at parks in cities and towns.

KEY REFERENCES: Bent 1938, Earhart and Johnson 1970, Forbush 1929.

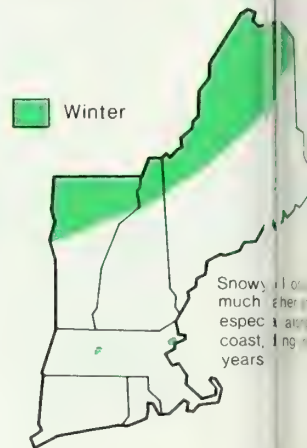
Snowy Owl

(*Nyctea scandiaca*)

A.O.U. No. 376.0



Range



RANGE: Breeding: Arctic tundra n. of the tree line in n. hemisphere. Winter: As far s. as n. New York, Vermont, New Hampshire, and Maine, occasionally occurs s. to n. Alabama and Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Birds move s. periodically in response to crash of lemming population, otherwise, rare in the Northeast.

HABITAT: Open areas along coast, including areas along airport runways.

FORAGING: Major foods: Lemmings, other small mammals and small birds. Substrate: snow-covered fields, inland and coastal marshes. Techniques: Hawking, hovering, pouncing.

KEY REFERENCES: Bent 1968, Burton 1973.

Northern Hawk-Owl

(*urnia ulula*)

O.U. No. 377.0



Range



RANGE: Breeding Boreal forest of n. hemisphere. Winter: same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare. Winter: Occasionally trickles down into northeastern states.

HABITAT: Coniferous forest.

FEEDING: Major foods: Small mammals, and small to medium birds. Substrate: ground. Technique: Hovering and pouncing.

KEY REFERENCES: Bent 1938, Hausman 1966.

Barred Owl

(*Strix varia*)

A.O.U. No. 368.0



Range

 Permanent



RANGE: Breeding: Newfoundland, w. to Alberta, s. to Florida and the Gulf Coast. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon and scattered.

HABITAT: Breeding: Low, wet deep woods, heavily wooded swamps often near open country where it may hunt for food. Frequently uses mixed or coniferous woods for nesting and roosting. Prefers mature oak woods for nesting and feeding (Hardin and Evans 1977). Wintering: In times of food shortage, birds often migrate south in search of food.

SPECIAL HABITAT REQUIREMENTS: Cool, damp lowlands, large trees with cavities for nesting. Minimum d.b.h. of suitable trees is 20 inches (50.8 cm) (Thomas et al. 1979).

NESTING: Egg dates: March 23 to May 3, New York (Bull 1974:334). Clutch size: 2 to 4, typically 2 or 3. Incubation period: 28 to 33 days. Nestling period: 28 to 35 days. Broods per year: 1. Nest height: To 80 feet (24.4 m). Nest site: Typically in a large natural cavity in a dead tree. Where cavities are scarce, it may use old bird or squirrel nests. In New York, owls often roost in dense stands of hemlock or pines (Bull 1974:333).

HOME RANGE: Average size for 9 owls was 565 acres (228.7 ha) (range 213 to 912 acres (86.2 to 369.2 ha)) in deciduous woodland—open field—marsh habitat in Minnesota (Nicholls and Warner 1972).

SAMPLE DENSITIES: 3 pairs per 36 square miles (3 pairs per 93.2 km²) in extensive deciduous woodlots in Michigan (Craighead and Craighead 1969:92). 0.5 pair per 40 acres (40 ha) in lowland forest in Maryland (Stewart and Robbin 1958: 180).

FORAGING: Major foods: Mice (staple) and other mammals, frogs, birds, insects, crayfish. Substrates: Forest floor, meadow grasses. Techniques: Swinging and pouncing. Preferred feeding habitat: Open fields surrounded by woodland.

COMMENTS: Barred Owls are nocturnal hunters. Birds with broods may hunt during daylight hours.

KEY REFERENCES: Bent 1938, Errington and McDonald 1937, Forbush 1929.

Great Gray Owl

(*Nyctalex nebulosa*)

O.U. No. 370.0



Range



RANGE: Breeding: Boreal forest throughout the n. hemisphere. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare. May increase in the Northeastern United States in large numbers when the snow is deep and food is in low supply farther north.

HABITAT: While wintering in settled parts of the country, various woodland types, frequently deciduous are used. It often hunts meadow mice in open fields using fence lines, low trees, shrubbery, and wooded edges as lookouts. (Godfrey 1979:217)

FEEDING: Major foods: Small mammals, small birds. Foraging strategy: Ground. Technique: Swooping and pouncing. Preferred feeding habitat: Meadows.

REFERENCES: Burton 1973, Godfrey 1979.



Long-eared Owl

(*Asio otus*)

A.O.U. No. 366.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland, Quebec, w. to British Columbia, s. to Virginia and Arkansas. Winter: Central Maine w. to British Columbia, s. to Florida and c. Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Maine) to rare (Massachusetts) in breeding season. Uncommon in winter.

HABITAT: Breeding: Deciduous or coniferous (coniferous preferred) and open or dense woodlands, wooded parks, sometimes in small woodlots. Wooded swamps, evergreen plantations. Wintering: Birds roost deep within groves of evergreens that may be several miles from extensive forest.

SPECIAL HABITAT REQUIREMENTS: Dense vegetation for nesting and roosting cover.

NESTING: Egg dates: March 21 to May 23, New York (Bull 1974:336). Clutch size: 3 to 8, typically 4 to 5. Incubation period: About 28 days. Age at first flight: 23 to 24 days. Broods per year: 1. Nest site: Often in old crow, hawk, or squirrel nest, sometimes in natural tree cavities or on top of broken stubs. Rarely on ground or ledges.

SAMPLE DENSITIES: 1 pair per 37 square miles (1 pair/95.8 km²) in Michigan. 1 pair per 4 square miles (1 pair/10.4 km²) in Wyoming (Craighead and Craighead 1969:212, 215). 1 pair per 0.1 to 0.4 square mile (1 pair/0.3 to 1.0 km²) in Wyoming (Craighead and Craighead 1969:264).

FORAGING: Mice (staple) and other small mammals, reptiles, amphibians, insects, occasionally takes small birds. Substrates: Forest floor, meadow grasses. Techniques: Swooping and pouncing. Preferred feeding habitat: Both wooded and open country.

COMMENTS: Birds are gregarious in winter with flocks of 5 to 25 occupying communal roosts (Pough 1949). Their quiet and nocturnal habits make them difficult to observe in all seasons.

KEY REFERENCES: Armstrong 1958, Bent 1938, Forster 1929.

Short-eared Owl

(*Nyctaleus flammeus*)

U. No. 367.0



Range



DISTRIBUTION: Breeding: Arctic, s. to New Jersey, Ohio and c. California. Winter: Massachusetts, Ohio, s. British Columbia, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon in the interior but occasionally locally common along coast in wintering season. Winters locally throughout.

HABITAT: Breeding: Open grasslands, plains, marshes, etc. Wintering: Same as breeding habitat generally but wintering in localities with little or no snow.

ESSENTIAL HABITAT REQUIREMENTS: Extensive open grasslands with abundant rodents.

REPRODUCTION: Egg dates: April 12 to May 19, New York (Bull 1938). Clutch size: 4 to 9, typically 5 to 7. Incubation period: About 21 days. Age at first flight: About 28 days. Fledging period: 12 to 16 days. Broods per year: 1. Nest site: On the ground in clumps of weeds or grasses; rarely in trees.

NESTING SITE SIZE: 73.9 to 121.4 ha (182.5 to 299.8 acres) in grasslands and rushes in New York (Clark 1975:43).

FEEDING: Major foods: Mice, insects, occasionally small mammals. Substrates: Grass—fields, dunes. Techniques: Hovering, and pouncing.

COMMENTS: In winter, birds tend to roost in groups in open field or close to ground in conifers or brush if snow is deep. Birds often hunt by day (especially dawn and dusk) and depend almost totally on rodents.

KEY REFERENCES: Bent 1939, Clark 1975, Short and Drew 1962, Stegeman 1957.

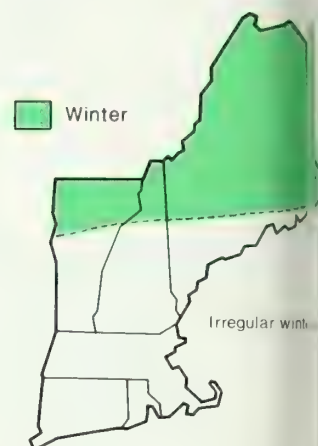
Boreal Owl

(*Aegolius funereus*)

A.O.U. No. 371.0



Range



RANGE: Breeding: Boreal forests of western hemisphere. Winter: same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Occasionally winters in northeastern border states.

HABITAT: Mixed hardwoods and coniferous forests.

FORAGING: Major foods: Small mammals and small birds. Substrate: Forest floor. Technique: Swooping and pouncing.

KEY REFERENCE: Burton 1973.

Northern Saw-whet Owl

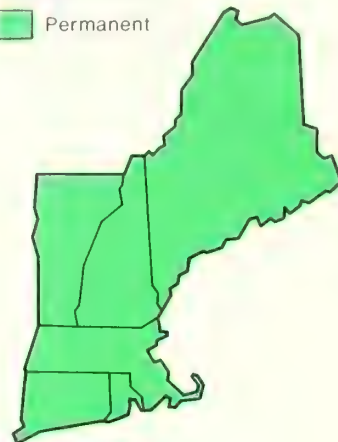
(*Nyctaleilus acadicus*)

U. No. 372.0



Range

 Permanent



DISTRIBUTION: Breeding: Nova Scotia, w. to se. Alaska, s. to c. and s. New England. Breeds in the mountains from Canada to Missouri. Winter: Regularly s. to Virginia usually to s. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Uses a variety of habitats, including podlots, roadside shade trees, coniferous and deciduous forests. Swampy areas in deep coniferous forests preferred over dry deciduous woods (Pough 1923). Mature mixed forests with scattered dead trees preferred nesting habitats (Angell 1974). Wintering: In deep snow makes food unavailable, birds may be in search of prey. Birds roost in conifers at edge of or in interior of extensive woodlands. Also in coniferous woods in parks and isolated pines.

NESTING HABITAT REQUIREMENTS: Cavity in tree with a minimum d.b.h. of 12 inches (30.5 cm) (Thomas et al. 1979).

REPRODUCTION: Egg dates: March 31 to June 11, New York (Simpson 1974:340). Clutch size: 4 to 7, typically 5 or 6. Incubation period: 21 to 28 days. Broods per year: 1 (Terrill 1961). Nest height: 14 to 60 feet (4.3 to 18.3 m). Typically 10 to 20 feet (6.1 to 12.2 m). Nest site: Usually in cavity of a tree. Prefers old deserted Woodpecker holes, especially those of Flickers. Birds accept nest boxes with a bed of straw or sawdust inside.

RESEARCH RANGE: Approximately 350 acres (141.7 ha) in Minnesota (Simpson 1972).

SAMPLE DENSITIES: 1 bird per 1.86 square miles (1 bird/4.8 km²) in spruce-fir in mountains of North Carolina (Simpson 1972). Maximum 1 pair per 40 ha (100 acres) (Hardin and Evans 1977).

FORAGING: Major foods: Mainly small mammals—especially mice, young squirrels, shrews, chipmunks; also takes insects and occasionally small birds. Substrate: Forest floor. Techniques: Swooping and pouncing.

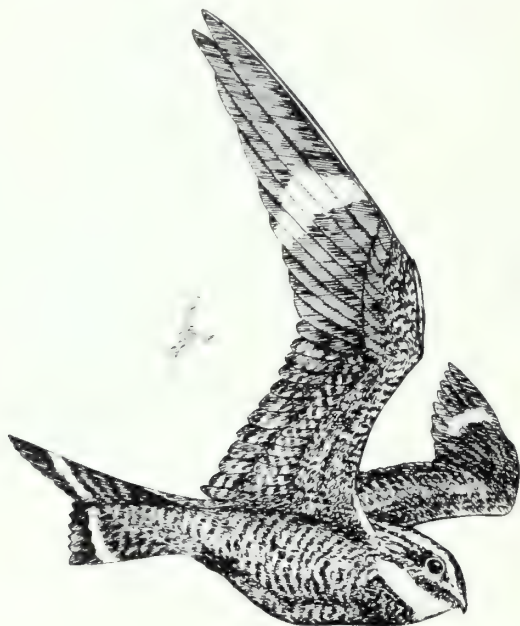
COMMENTS: Saw-whet Owls hunt and roost close to the ground. They are nocturnal and so are seldom seen.

KEY REFERENCES: Bent 1938, Mendall 1944, Randle and Austing 1952.


Common Nighthawk

(*Chordeiles minor*)

A.O.U. No. 420.0



Range

 Breeding



RANGE: Breeding: Newfoundland, Quebec, w. to s. Yukon, s. to the Gulf States and n. Mexico. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to rare.

HABITAT: Breeding: Open areas such as plowed fields, gravel beaches, barren areas with rocky soil, railroad right-of-ways, large woodland clearings, cities. Nesting in cities restricted to gravel roofs. Most Massachusetts birds nest on gravel roofs.

NESTING: Egg dates: May 25 to July 25, New York (Bull 1974:345). Clutch size: 1 or 2, typically 2. Incubation period: 19 days. Age at first flight: About 3 weeks. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: Builds no nest. Lays eggs on bare ground usually on gravel or partially vegetated soil, roof tops; always in open.

TERRITORY SIZE: Armstrong (1965) found that territories coincided with breeding home ranges in Michigan (see Home Range).

HOME RANGE: 4.1 to 22.8 ha (10.1 to 56.3 acres) (average 10.4 ha (25.7 acres)) per pair in Michigan (Armstrong 1965).

SAMPLE DENSITIES: 13 birds per 130 ha (321.1 acres) in Michigan (Armstrong 1965).

FORAGING: Major foods: Flying insects, especially flying ants, mosquitos, moths, grasshoppers. Substrate: Air. Technique: Air screening.

COMMENTS: Birds are mainly crepuscular and nocturnal but occasionally feed during the day. Numbers seem to be declining in New Hampshire (C. Anderson, personal communication).

KEY REFERENCES: Armstrong 1965, Bent 1940, Bull 1963.

Whip-poor-will
(*Caprimulgus vociferus*)

U. No. 417.0



Range



DISTRIBUTION: Breeding: Nova Scotia and s. Quebec, w. to c. New Brunswick, s. to e. Virginia (coast), Alabama, Georgia (mountains), and Texas. Winter: South Carolina, w. Florida, and Gulf States and s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Dry, open, predominantly deciduous woodlands—often with small to medium trees of white oak, and beech. Less common breeder in mature forests; avoids mountains.

REPRODUCTION: Egg dates: May 16 to June 30, New York (Bull 1944). Clutch size: 1 or 2, typically 2. Incubation period: 20 days. Broods per year: 1 or 2 (Bull 1974:344). Attains sexual maturity: 1 year. Nest site: Builds no nest. Eggs are laid on well-drained ground in the open or under low brush. Often among trees at edge of clearing or in open fields.

TERRITORY SIZE: 14.9 acres (6 ha), 25.5 acres (11.1 ha), and 9 acres (2.8 ha) in oak, hickory, elm woodlands in Maryland (Fitch 1958).

POPULATION DENSITIES: 1.4 territorial males per 100 acres (40 males per 100 acres) in upland forest and brush habitat in Maryland (Stewart and Robbins 1958:184).

FORAGING: Major foods: Mainly flying insects but occasionally takes crickets, ants, and beetles from the ground (Bent 1940). Substrates: Air, leaf litter. Technique: Air screening.

KEY REFERENCES: Bent 1940, Raynor 1941.


Chimney Swift

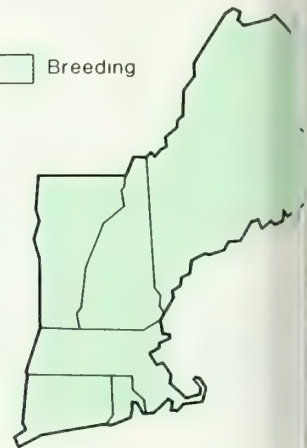
(*Chaetura pelagica*)

A.O.U. No. 423.0



Range

 Breeding



RANGE: Breeding: Southern Canadian provinces, s. to Florida and the Gulf Coast. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: The vicinity of buildings in towns, cities, farms.

SPECIAL HABITAT REQUIREMENTS: Chimneys.

NESTING: Egg dates: May 30 to July 27, New York (Bull 1974:347). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 18 to 21 days. Nestling period: 1 or 2 days (able to crawl out of nest but unable to fly). Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Formerly nested in hollow trees but has adapted to chimneys, silos, building walls, rafters, airshafts, old wells. At Kent, Ohio, birds typically nested in ventilation shafts at an average depth of about 20 feet (6 m) (Dexter 1977). Solitary or colonial nesters.

SAMPLE DENSITIES: 0.6 pair per 100 acres (40 ha) in mixed forest, brush and field, and near buildings with chimneys (Stewart and Robbins 1958:187).

FORAGING: Major foods: Flying insects. Substrate: Air. Technique: Air screening.

KEY REFERENCES: Bent 1940, Dexter 1977, Fischer 1958.

Rufous-throated Hummingbird

Amazilia colubris

U. No. 428.0



Range

Breeding



DISTRIBUTION: Breeding: Nova Scotia, w. to s. Alberta, s. to Texas. Winter: Mexico and Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Mixed woodlands, shade trees in rural landscapes, orchards. Often near streams and flooded swamps.

LOCAL HABITAT REQUIREMENTS: Abundant flowers, preferably red.

REPRODUCTION: Egg dates: May 21 to August 16, New York (1974:348). Clutch size: Invariably lays 2 eggs. Incubation period: 11 to 16 days. Nestling period: 14 to 28 days (Bent 1940). Broods per year: 1. Nest height: 6 to 50 cm (0.8 to 15.2 m), typically 10 to 20 feet (3.0 to 6.1 m). Site: Nest is usually built in the saddle of a drooping branch of a shrub or tree often near, and sometimes directly over water or near a woodland trail. It is usually sheltered above by leaves and branches and exposed to the sun below.

TERRITORY SIZE: Female alone defends immediate area surrounding nest. A male in Ohio defended a feeding territory of 0.25 acre (0.1 ha) (Pitelka 1942).

POPULATION DENSITIES: Maryland—15 pairs per 100 acres (40 ha) in well-drained floodplain forest. 8 pairs per 100 acres (40 ha) in upland oak forest. 6 pairs per 100 acres

(40 ha) in mature northern hardwood forest. 4 pairs per 100 acres (40 ha) in hedgerows and active and abandoned farmland (Stewart and Robbins 1958:188).

FORAGING: Major foods: small insects, nectar, sap. Substrate: Flowers. Techniques: Hovering, hawking. Preferred feeding habitat: Wherever there are abundant flowers.

COMMENTS: Pair bond: males are polygynous. Sexes migrate separately with males arriving in the Northeast several days before the females. In fall, males leave for wintering grounds a month before females and young.

KEY REFERENCES: Bent 1940, Pickens 1936, Pitelka 1942.



Belted Kingfisher

(*Ceryle alcyon*)

A.O.U. No. 390.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Mackenzie district, Northwest Territories and n. Alaska, s. to Florida, Texas, and s. California. Winter: Great Lakes and s. New England, s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in breeding season. Uncommon in winter.

HABITAT: Breeding: Banks near ponds, lakes, rivers, and streams that contain fish. Wintering: Near ice-free waters that allow access to food.

SPECIAL HABITAT REQUIREMENTS: Banks for nest sites within a mile of water. Water with low turbidity and adequate food supply. Perches near water for sighting prey.

NESTING: Egg dates: May 1 to June 10, New York (Bull 1974: 349). Clutch size: 5 to 8, typically 6 or 7. Incubation period: 23 to 24 days. Nestling period: 31 to 32 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Typically 3 to 6 feet (1 to 2 m) deep in a burrow in a bank of sandy clay or gravel near water. Banks may be up to a mile from water forcing birds to travel to distant feeding areas.

HOME RANGE: 2 pairs on 2 lakes used 0.5 mile (0.8 km) of shoreline (Sayler and Lagler 1946). 0.5 to 5 miles (0.8 to 8 km) from nest site (Cornwell 1963).

SAMPLE DENSITIES: 1 pair per 1.8 square miles (1 pair/4.7 km²) in Minnesota (Cornwell 1963).

FORAGING: Major foods: Fish (staple), crayfish, insects, mollusks, tadpoles, occasionally takes fleshy fruits. Substrates: Shallow water (less than 2 feet (0.6 m) deep). Techniques: Diving, skimming water surface. Preferred feeding habitat: Shallow borders of bodies of water.

COMMENTS: Large lakes that become turbid due to water action have fewer Kingfishers than small clear bodies of water.

KEY REFERENCES: Bent 1940, Cornwell 1963, Sayler and Lagler 1946, White 1953.

Red-headed Woodpecker

(*Caprimulgus erythrocephalus*)

U. No. 406.0



Range

 Breeding



RANGE: Breeding: Southwestern Quebec, w. to se. Alberta, s. to the Gulf Coast. Does not breed in n. New England. Winter; Southeastern Pennsylvania, w. to Oklahoma and s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Lowland and upland habitats, river bottoms, wooded swamps, beaver ponds, open deciduous woods, groves of dead and dying trees, orchards, and agricultural country. Prefers savanna-like grasslands with scattered trees and forest edges. Wintering: Birds move from forest interior. Oaks and maples that provide mast may be important components of winter habitat (Willson 1970, Reller 1972).

SPECIAL HABITAT REQUIREMENTS: Prefers open areas with snags and lush herbaceous ground cover (Hardin and Evans 1977).

REPRODUCTION: Egg dates: May 16 to June 19, New York (Bull 1977:355). Clutch size: 4 to 7, typically 5. Incubation period: About 14 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 8 to 80 feet (2.4 to 24.4 m), typically 23 to 40 feet (7 to 12.4 m). Nest site: The cavity usually excavated in dead tree or limb without bark that is surrounded by open space, utility poles, or other bird houses. Prefers open woods with dead trees and herbaceous ground cover.

TERRITORY SIZE: In winter the birds restrict their activities to small, well-defined territories (Kilham 1958b).

SAMPLE DENSITIES: 9 to 12 birds per 100 acres (40 ha) in bottomland woods with much edge and large internal openings (oak-hickory-hackberry-elm community) (Graber et al. 1977). 25 birds per 100 acres (40 ha) in suburban-residential habitat (Cooke 1916 in Graber et al. 1977). 28 birds per 100 acres (40 ha) in shrub area (Graber and Graber 1963).

FORAGING: Major foods: Insect larvae and adults, wild fruits, acorns (especially those of pin oak), beechnuts, corn. Substrates: Ground, trunks, and limbs. Techniques: Drilling, probing, ground gleaning, hawking. Preferred feeding habitat: Open areas adjacent to woodlots (Connor 1976); upper parts of trees in winter (Williams 1975b).

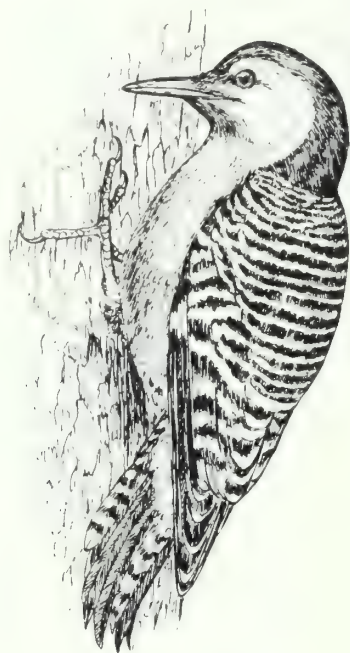
COMMENTS: Reller (1972) found that Red-headed Woodpeckers favored cavities in trunks rather than limbs. Red-headed populations have increased following the death of trees over a large area by fire, flood, or disease (Graber et al. 1977). Woodlots used for nesting in sw. Virginia ranged from 0.5 to 20.0 ha (1.2 to 50 acres) (Conner 1976).

KEY REFERENCES: Bent 1939, Conner 1976, Graber et al. 1977, Reller 1972.


Red-bellied Woodpecker

(*Melanerpes carolinus*)

A.O.U. No. 409.0



Range

 Breeding



RANGE: Breeding: New Jersey, Pennsylvania, New York, w. to s. Minnesota, s. to the Gulf Coast. Occasionally breeds in s. New England. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to rare.

HABITAT: Breeding: Deciduous and coniferous forests and edges; frequents uplands but prefers bottomlands, woodlots near farms and villages, orchards. Wintering: Similar to breeding habitat. Birds are sedentary, remaining on breeding grounds year-round.

SPECIAL HABITAT REQUIREMENTS: Extensive mature woodlands with dead trees or trees with large dead limbs for nesting.

NESTING: Egg dates: April 26 to June 28, New York (Bull 1974:354). Clutch size: 3 to 8, typically 4 to 6. Incubation period: 14 days. Broods per year: 1 (north), 2 (south). Age at sexual maturity: 1 year. Nest height: 5 to 70 feet (1.5 to 21.3 m). Nest site: Cavity in sound or soft wood, often in limb at edge of woodland, less often in trunk of dying or dead tree, building, utility pole, or stump. Frequently uses nesting boxes. May excavate a cavity or occupy an existing one (Kilham 1958a).

TERRITORY SIZE: Average 6.1 acres (2.5 ha) (3 territories) in virgin floodplain forest in Illinois. Average 4.4 acres (1.8 ha) (2 territories) in mature upland forest in Illinois (Graber et al. 1977). Winter: 3 to 4 acres (1.2 to 1.6 ha) (Kilham 1963).

SAMPLE DENSITIES: 23 birds per 100 acres (40 ha) in virgin floodplain (elm-maple) forest in Illinois. 6 birds per 100 acres (40 ha) in bottomland forest in Illinois (Graber et al. 1977). 19 pairs per 100 acres (40 ha) in white oak tulip-poplar forest in Maryland (Stewart and Robbins 1958:193).

FORAGING: Major foods: Insects, especially ants and beetles; beech and acorn mast, corn, wild fruits. Substrates: Upper dead limbs of trees, ground. Techniques: Scaling, probing, gleaning tree surfaces, drilling, ground foraging. Preferred feeding habitat: Lowland (Williams 1975). Birds may seek food in areas outside breeding habitat (such as cornfields) (Reller 1972).

COMMENTS: Reller (1972) found that Red-bellied Woodpeckers favored dead limbs in living trees for nest sites. Birds compete with starlings for cavities. Birds often store food in crevices for later use (Kilham 1963). Yeager (1955) noted that populations increased where flooding had killed trees.

KEY REFERENCES: Bent 1939, Graber et al. 1977, Kilham 1963, Reller 1972.

Low-bellied Sapsucker

(*Pyrapicus varius*)

U. No. 402.0



Range



NE: Breeding: Newfoundland, w. to Alaska, s. to the
tains of Massachusetts, Virginia, Georgia, Mis-
and New Mexico. Winter: Southern New England
Kansas and s. British Columbia, s. to Central Amer-

VE ABUNDANCE IN NEW ENGLAND: Uncommon (se.
York) to common (Maine).

EAT: Breeding: Mixed hardwood-conifer forests, es-
specially near water and small clearings, woodlots, occa-
sionally in orchards. Wintering: Floodplain forest and
the ornamental conifers.

LOCAL HABITAT REQUIREMENTS: Trees with a d.b.h. of
inches (25.4 cm) or more are most suitable for nesting
(Lawrence et al. 1979).

SING: Egg dates: April 29 to June 19, New York (Bull
1938). Clutch size: 4 to 7, typically 5 or 6. Incubation
period: 12 to 14 days. Nestling period: 24 to 26 days.
Eggs per year: 1. Age at sexual maturity: 1 year. Nest
height: 8 to 40 feet (2.4 to 12.2 m) Nest site: Excavates a
hole in a dead or living tree with rotten heartwood.
Nests in a variety of trees but prefers aspen when availa-
ble (Lawrence 1967, Howell 1952). Favors trees infected
by *Homos* (Kilham 1971).

TERRITORY SIZE: Varies from immediate vicinity of nest to
100 acres (137.2 m) or more (Howell 1952).

HOME RANGE: 5.1 acres (2.1 ha) and 5.4 acres (2.2 ha) for
2 pairs in mature second-growth forest in Ontario
(Lawrence 1967).

SAMPLE DENSITIES: Winter — 12 birds per 100 acres (40
ha) in bottomland forest in Illinois (Graber et al. 1977).

FORAGING: Major foods: Inner bark of trees, sap, insects
(excluding wood-boring larvae), fruits and berries. Sub-
strates: Smooth bark on trunks of small and large living
trees and limbs of larger trees. Techniques: Drilling,
hawking, probing.

COMMENTS: Beal (1911 in Graber et al. 1977) found that
the contents of 313 stomachs contained 49 percent ani-
mal and 51 percent vegetable matter. Poison ivy berries
are an important winter food during prolonged subfreez-
ing weather (Robbins, personal communication).

KEY REFERENCES: Bent 1939, Graber et al. 1977, Howell
1952, Kilham 1962, Lawrence 1967.

Downy Woodpecker

(*Picoides pubescens*)

A.O.U. No. 394.0



Range



Permanent



RANGE: Breeding: Newfoundland, w. to nw. Alaska, s. to Florida and New Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Interior and edges of open mixed woodlots and forests (prefers bottomlands), orchards, shade trees in towns, suburbs. Prefers habitat with living and dead medium-sized trees 10 to 22 inches (25.4 to 55.9 cm) d.b.h. Shugart et al. (1974) found a high correlation between downy distribution and sapling density, indicating that sapling removal may decrease downy habitat. Wintering: Bottomland forest, shrub habitat, upland areas with large trees, forest edges. Birds on high mountains move to lower elevations.

SPECIAL HABITAT REQUIREMENTS: Trees greater than 6 inches (15.2 cm) d.b.h. for nesting (Thomas et al. 1979).

NESTING: Egg dates: May 6 to June 30, New York (Bull 1974:359). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 12 days. Nestling period: 20 to 22 days (post-fledgling care continues for 3 weeks) (Lawrence 1967). Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 3 to 50 feet (0.9 to 15.2 m), typically 20 feet (6.1 m). Nest site: Cavity in living or dead tree, in sound or rotting wood, stump, often on underside of limb. Conner and others (1975) found nests in trees 8 to 12 inches (20 to 30 cm) d.b.h. Prefers to nest in open woodlands in upper parts of dead trees (Scott et al. 1977). Cavity excavated for courtship activity and nesting. A separate cavity is

excavated in fall for winter roosting (Harrison 1975). Often re-excavates same tree year after year (Hardin and Evans 1977).

TERRITORY SIZE: 1.3 to 3.1 acres (0.5 to 1.3 ha) (average 2.0 acres (0.8 ha)) for 9 pairs in mature lowland forest in Illinois (Calef 1953 in Graber et al. 1977).

HOME RANGE: 5 to 8 acres (2.0 to 3.2 ha) is estimated size for 2 pairs in second-growth forest in Ontario (Lawrence 1967).

SAMPLE DENSITIES: 36 birds per 100 acres (40 ha) in virgin floodplain forest in Illinois (Snyder et al. 1948). Maximum 13 pairs per 40 ha (100 acres) (Hardin and Evans 1977).

FORAGING: Major foods: Insects, especially wood-boring ants and beetle larvae. Substrates: Bark crevices on trunks and branches of living and dead trees, under loose bark. Techniques: Scaling, drilling, probing, gleaning, flight-gleaning, hawking. Preferred feeding habitat: Woodlands with elms and oaks. Downies generally feed on lower branches and trunk.

COMMENTS: Females tend to forage on small branches less than 5 cm (2 inches) in diameter; males tend to forage on trunks (Jackson 1970). Beal (1911 in Bent 1933) found 76 percent animal and 24 percent vegetable material in 723 stomachs.

KEY REFERENCES: Conner et al. 1975, Graber et al. 1977, Jackson 1970, Lawrence 1967.

Gray Woodpecker

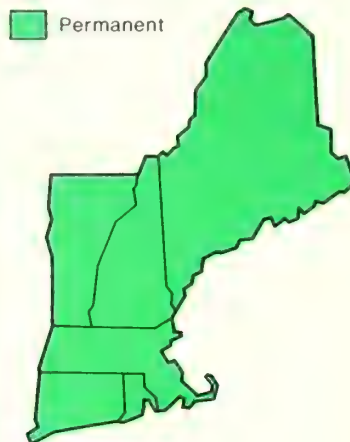
(*Geococcyx villosus*)

U. No. 393.0



Range

Permanent



C: Breeding: Newfoundland, w. to Alaska, s. to Central America. Winter: Same as breeding range.

VE ABUNDANCE IN NEW ENGLAND: Common.

AT: Breeding: Open coniferous, deciduous and mixed woodlands with mature living and dead trees, and swamps. Prefers bottomland areas with large trees. Wintering: A shift to more residential habitat occurs in s. Illinois (Graber et al. 1977). Birds may move to open country (Pough 1949).

IL HABITAT REQUIREMENTS: Trees with a d.b.h. of 25.4 cm or more are most suitable for nesting (Graber et al. 1979).

EG: Egg dates: April 23 to May 19, New York (Bull 1959). Clutch size: 3 to 6, typically 4. Incubation period: 11 to 12 days. Nestling period: 28 to 30 days. Reproductive rate: 1 (north), 2 (south). Age at sexual maturity: 1 year. Nest height: 15 to 45 feet (4.6 to 13.7 m), usually 35 feet (10.7 m). Nest site: Cavity in living (often dead tree, in trunk or underside of large limb) or trees with decayed interiors. Conner and others (1955) found nests in trees with d.b.h. range of 12 to 18 inches (30.5 to 45.7 cm). Nests were in both dead trees and parts of living trees in sparsely to fully stocked

acres, 1.1 ha) in mature bottomland in Illinois (Calef 1953 in Graber et al. 1977).

HOME RANGE: 6 to 8 acres (2.4 to 3.2 ha) (estimated minimum sizes of 2 ranges) in second growth forest in Ontario (Lawrence 1967).

SAMPLE DENSITIES: 17 to 24 birds per 100 acres (40 ha) in mature bottomland forest in Illinois (Calef 1953 in Graber et al. 1977). 4 birds per 100 acres (40 ha) in upland oak-hickory forest in Illinois (Franks and Martin 1967).

FORAGING: Major foods: Adults and larvae of beetles, ants and caterpillars are staples, but also eats fruits, nuts, corn. Substrates: Bark crevices of living and dead trees, trunks, branches, rotting stumps, under loose bark. Techniques: Gleaning, drilling, scaling.

COMMENTS: Birds are highly sedentary and may remain on home range for life. Females tend to feed lower on different species of trees than males and forage by different technique (Kilham 1965, 1968a), a behavior that lessens competition.

KEY REFERENCES: Bent 1939, Conner et al. 1975, Graber et al. 1977, Kilham 1960, Lawrence 1967.

RY SIZE: 6.5 acres (2.6 ha) (one territory) in mature bottomland forest in Illinois (Allison 1947 in Graber et al. 1977). 1.6 to 3.7 acres (0.6 to 1.5 ha) (average 2.6

Three-toed Woodpecker

(*Picoides tridactylus*)

A.O.U. No. 401.0



Range



Permanent



RANGE: Breeding: Northern edge of Canadian boreal forest s. to n. New England, Arizona, and New Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: Breeding: Coniferous forests, especially where fires have left large stands of dead timber. Also favors logged areas and swamps with scattered dead trees.

SPECIAL HABITAT REQUIREMENTS: Trees with a minimum d.b.h. of 12 inches (30.5 cm) for nesting (Thomas et al. 1979).

NESTING: Egg dates: May 14 to June 14, New York (Bull 1974:363). Clutch size: Typically 4. Incubation period: About 14 days. Broods per year: 1. Nest height: 5 to 12 feet (1.5 to 3.7 m), rarely to 40 feet (12.2 m). Nest site: A cavity in a living or dead tree, often in a burned stand. Loosely colonial in areas with abundant food.

FORAGING: Major foods: Wood-boring larvae of moths and beetles, cambium. Substrates: Trunks of trees (bark crevices). Short (1974) observed birds in New York feeding mainly in the upper parts of live conifers. Techniques: Probing bark, drilling.

COMMENTS: Birds are sedentary, rarely leave home ranges. Seldom venture far from deep woods. Diet is greater than 90 percent animal matter and less than 10

percent vegetable matter. 75 percent of the animal portion consists of wood boring larvae (Bent 1939:118).

KEY REFERENCES: Bent 1939, Harrison 1975, Short 1974

Black-backed Woodpecker

(*Picoides arcticus*)

O.U. No. 400.0



Range

Permanent



RANGE: Breeding: Newfoundland, w. to c. Alaska, s. to New England, nw. Wyoming and c. California. Winter: Same as breeding range, occurs irregularly s. to s. New England, Long Island, and n. New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Coniferous forests, especially where burned or logged where swampy conditions predominate. Favors spruce-fir and larch. Also prefers large tracts of balsam fir killed by spruce-budworm. Wintering: Same as breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Dead trees with loose bark for feeding. Trees with a minimum d.b.h. of 12 inches (30.5 cm) for nesting (Thomas et al. 1979).

REPRODUCTION: Egg dates: May 18 to June 12, New York (Bull 194:360). Clutch size: 2 to 6, typically 4. Incubation period: About 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 15 feet (0.6 to 4.6 m). Usually excavates a new cavity each year as part of courtship activity, as well as for roosting. Nest site: Excavates a cavity in a living tree with a decayed interior or a dead tree or stub (often balsam fir). Sometimes used old utility poles. Birds in New York nested in small open areas with windfalls and dead trees (Bent 1939:106). Birds in New York almost invariably nested in dead trees (Bull 194:361).

FEEDING: Major foods: Bark-boring beetle larvae and other insects, cambium. Substrates: Under loose bark,

decayed heartwood, crevices in bark, lower parts of dead trees. Techniques: Probing bark, scaling off loose bark, drilling. Preferred feeding habitat: Beaver swamps and other places where there are recently killed trees with loose bark. Short (1974) observed black-backs feeding mainly in dead trees bordering a bog.

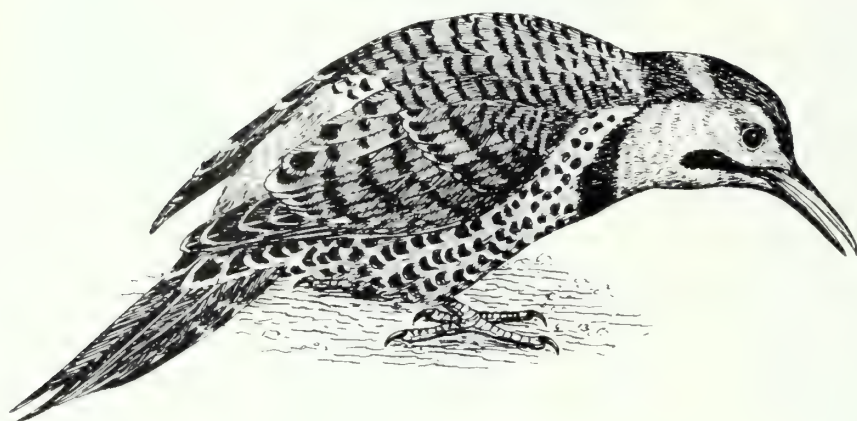
COMMENTS: Bark-boring beetle larvae account for 75 percent of the volume of animal food. The remaining 25 percent consists of other insects and spiders, and plant materials.

KEY REFERENCES: Bent 1939, England 1940, Harrison 1975, Short 1974.

Northern Flicker

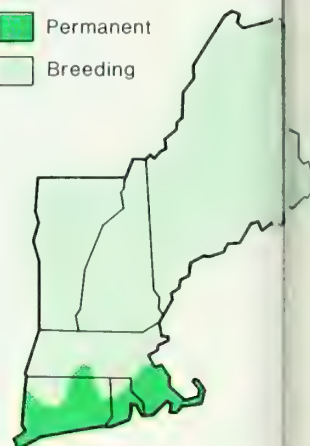
(*Colaptes auratus*)

A.O.U. No. 412.3



Range

- Permanent
- Breeding



RANGE: Breeding: Labrador w. to Alaska (northern tree limit) s. to Florida, the Gulf Coast, and Central America. Winter: Central New England, w. to South Dakota, s. to the Gulf Coast.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Open deciduous, coniferous, or mixed woods, woodland edges (preferred), suburbs, farm woodlots, clearcuts in dense forests, fields, meadows. Wintering: Occasionally seeks protection from cold in coniferous woods or swamps.

SPECIAL HABITAT REQUIREMENTS: Medium to large dead or dying trees for nesting. Open areas for foraging. Trees 12 inches (30.5 cm) d.b.h. or more are most suitable for nesting (Thomas et al. 1979).

NESTING: Egg dates: April 20 to June 19, New York (Bull 1974:351). Clutch size: 3 to 10, typically 6 to 8. Incubation period: 11 to 12 days. Nestling period: About 23 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 60 feet (0.6 to 18.3 m). Typically 10 to 30 feet (3.0 to 9.1 m). Nest site: Cavity often near top of medium to large tree that is usually dead or dying. Flickers accept bird houses with proper dimensions and often use old vacant woodpecker holes. Nests in forests are usually located in snags near recent clearcuts. Forest edges or groves bordering fields are preferred nest sites.

TERRITORY SIZE: 1.55 acres (0.6 ha) in Illinois (Calef 1953 in Graber et al. 1977). Territorial defense is limited to

nest site during the incubation period. During this period, other Flickers may occupy original territory (Kilham 1973). Kilham (1973) observed 3 pairs on less than one acre (0.4 ha).

SAMPLE DENSITIES: Average 33.3 birds per 100 acres (40 ha) in second growth hardwoods in Illinois (Fawkes 1937, 1938 in Graber et al. 1977). 13 birds per 100 acres (4 ha) in oak-hickory type in Illinois (Franks and Martin 1977). 19 pairs per 100 acres (40 ha) in white pine woodland on Nantucket Island (Dennis 1969).

FORAGING: Major foods: Ants (staple) and a variety of other insects, especially ground beetles, cricket and grasshoppers. Also commonly takes wild fruits. Substrates: (surface and depths not exceeding the length of the bird's bill), leaf litter, short grasses, bark, under surface of bark. Techniques: Probing, gleaning. Preferred feeding habitat: Grassy areas such as lawns, pastures, openings in woods, cornfields (especially in winter).

COMMENTS: Beal (1911 in Bent 1939:277) found that about 61 percent of the diet consisted of animal food and about 39 percent vegetable food. Ants represented about 75 percent of the volume of animal material.

KEY REFERENCES: Bent 1939, Dennis 1969, Graber et al. 1977, Lawrence 1967.

Pileated Woodpecker

(*Dryocopus pileatus*)

A.O.U. No. 405.0



Range

 Permanent



RANGE: Breeding: Southeastern Canada, nw. to Mackenzie district, Northwest Territories, s. to Florida and Texas. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Extensive second growth and mature coniferous, deciduous, or mixed forests, often in woodlands near rivers and wooded swamps; woodlots near farms and residential areas. Prefer areas with high basal area and high stem density (Conner et al. 1975). Winter: Birds are permanent residents, generally remain in breeding habitat year round (Hoyt 1941). Birds have recently been found breeding in city parks with large trees (Bull 1974:352).

SPECIAL HABITAT REQUIREMENTS: Mature forest with large dead or dying trees greater than 14.2 inches (36 cm) for nesting and feeding. Trees with heart rot that attract carpenter ants, a winter staple (Conner et al. 1975).

REPRODUCTION: Egg dates: April 22 to May 19, New York (Bull 1944:352). Clutch size: 3 to 4, typically 4. Incubation period: 18 days. Nestling period: 26 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 15 to 40 feet (4.6 to 21.3 m), typically 45 feet (13.7 m). Nest site: Cavity in trunk of dead or, less often, living tree; sometimes in large dead limbs, preferably near water. Conner and others (1975) found pileated nests in trees with a d.b.h. range of 13 to 35.8 inches (33 to 91 cm) and average 21.5 inches (54.6 cm). They most often nested in trees 14.2 to 20.1 inches (36 to 51 cm) d.b.h. in oak-

hickory woodland and favored trees with smooth trunks and fungal activity. Hoyt (1957) observed that they rarely reuse old nest holes.

SAMPLE DENSITIES: 3 birds per 100 acres (40 ha) in virgin bottomland forest in Illinois (Snyder et al. 1948). 3 birds per 100 acres (40 ha) in mature bottomland forest in Illinois (Graber et al. 1977). 0 to 0.5 birds per 100 acres (40 ha) in mature upland forest in Illinois (Graber et al. 1977). 1 pair per 1,643 acres (665 ha) in ponderosa pine, Douglas-fir, and larch habitat in Oregon (Bull 1975). Maximum 1 pair per 98.8 acres (40 ha) (Hardin and Evans 1977).

FORAGING: Major foods: Larvae and adults of many kinds of insects, especially ants, which account for more than 50 percent of the diet. Also eats wild fruits, acorns, beechnuts (Bent 1939:183). Substrates: Trunks, bark, branches, decayed heartwood of living and dead standing trees. Most feeding is done in decayed wood (Tanner 1942). Techniques: Drilling, gleaning. Preferred feeding habitat: Feeding is restricted to forest interiors and, less commonly, edges (Bent 1939:184).

COMMENTS: Beal (1911 in Bent 1939:183) found that the contents of 80 stomachs contained 73 percent animal and 27 percent vegetable matter. The winter diet consists mainly of carpenter ants. Hoyt (1957) found that pileated woodpeckers have a feeding territory of 98.8 to 197.6 acres (40 to 60 ha).

KEY REFERENCES: Bent 1939, Bull 1975, Conner et al. 1975, Graber et al. 1977, Hoyt 1957.


Olive-sided Flycatcher

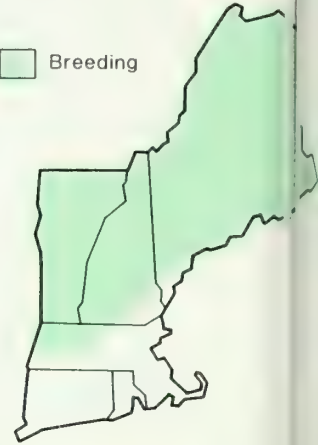
(*Contopus borealis*)

A.O.U. No. 459.0



Range

 Breeding



RANGE: Breeding: Newfoundland, w. to Alaska, s. in mountains to Pennsylvania, Wisconsin, Arizona, and s. California. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Coniferous (spruce) forests near edges and clearings, often along wooded streams and borders of northern bogs and muskegs, burned-over areas with a few dead trees for perches. Prefers to be near water.

NESTING: Egg dates: June 9 to June 27, New York (Bull 1974:378). Clutch size: 2 to 4, typically 3. Incubation period: 16 to 17 days. Nestling period: About 23 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 5 to 50 feet (2.1 to 15.2 m). Nest site: Usually well hidden on a horizontal branch high in a conifer, usually far out from the trunk.

TERRITORY SIZE: Breeding birds require an area of several acres (Harrison 1975:127).

FORAGING: Major foods: Insects, especially hymenopterans. Substrates: Air, surfaces of leaves. Techniques: Hawking, flight-gleaning.

COMMENTS: Typically perches in tree tops and on high, exposed (often) dead limbs for hawking.

KEY REFERENCES: Bent 1942.


Eastern Wood-Pewee

(*Contopus virens*)

C.O.U. No. 461.0



Range

 Breeding



RANGE: Breeding: Nova Scotia w. to s. Manitoba, s. to Florida and Texas. Winter: Central and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Interiors and edges of deciduous and coniferous forests, bottomlands, uplands, farm woodlots, roadsides, parks. Seems to be strongly associated with oaks (Graber et al. 1974), but occurs in more northern forests as well. Probably requires predominance of hardwoods.

REPRODUCTION: Egg dates: May 30 to July 20, New York (Bull 1944:378). Clutch size: 2 to 4, typically 3. Incubation period: 12 to 13 days. Nestling period: 15 to 18 days. Broods per year: 1, possibly 2. Nest height: 9 to 65 feet (2.7 to 19.7 m), typically 25 feet (7.6 m). Nest site: Typically saddled on horizontal limb of tree usually far from trunk. Sometimes on dead limb of living tree.

TERRITORY SIZE: 1.4 to 3.1 acres (0.6 to 1.3 ha) in lowland forest in Illinois (Fawver 1947 and Calef 1953 in Graber et al. 1974).

HOME RANGE: 10.8 acres (4.4 ha) Odum and Kuenzler 1955).

SAMPLE DENSITIES: Maryland — 19 pairs per 100 acres (40 ha) in virgin hardwood forest. 7 pairs per 100 acres (40 ha) in unsprayed apple orchard. 6 pairs per 100 acres (40 ha) in upland oak forest. 5 pairs per 100 acres (40 ha) in pine-oak forest (Stewart and Robbins 1958:207).

FORAGING: Major foods: Insects. Substrates: leaf surfaces, air. Techniques: Hawking, flight-gleaning, gleaning. Preferred feeding habitat: Woodland clearings, edges of fields, marshes; generally feeds in mid to lower tree canopy.

COMMENTS: Wood-Pewees occur in deciduous woodlands with relatively open understories. The nests are usually associated with openings. They will nest in a forest with a dense understory if canopy above is incomplete or sparse.

KEY REFERENCES: Bent 1942, Graber et al. 1974, Johnston 1971.


Yellow-bellied Flycatcher

(*Empidonax flaviventris*)

A.O.U. No. 463.0



Range

 Breeding



RANGE: Breeding: Newfoundland, w. to s. Mackenzie district, Northwest Territories, s. to n. New England, n. Pennsylvania (rarely) and c. Alberta. Winter: Mexico and Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine).

HABITAT: Breeding: Coniferous forests; low, wet, swampy thickets bordering ponds, streams and bogs, spruce and alder swamps, cool moist mountainsides.

SPECIAL HABITAT REQUIREMENTS: Coniferous forests, low wet areas.

NESTING: Egg dates: June 10 to June 27, New York (Bull 1974:371). Clutch size: 3 to 5, typically 3 or 4 (Harrison 1975:121). Incubation period: 15 days. Nestling period: 13 days. Age at sexual maturity: 1 year. Nest site: On or near the ground, sometimes at the base of a tree in a cavity formed by roots, but more often beside a hummock or mound and well hidden in sphagnum moss or other vegetation.

FORAGING: Major foods: Flying insects, fruits (occasionally). Substrate: Air. Technique: Hawking.

COMMENTS: Birds perch and feed close to ground. Food habit studies indicate a predominance of animal food (97 percent) over vegetable food (3 percent) (Beal 1912 in Bent 1942:178).

KEY REFERENCES: Bent 1942, Walkinshaw 1957.

Acadian Flycatcher

(*Empidonax virescens*)

O.U. No. 465.0



Range



Breeding



RANGE: Breeding: Most of e. North America, including Pennsylvania, sw. and se. New York and casually to New England. Winter: Costa Rica to n. South Amer-

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Deciduous woodlands, shaded ravines, heavily wooded bottomlands, river swamps, hammocks of cypress ponds (Harrison 1975:122).

NOTES: Egg dates: April to July. Clutch size: Usually 2 to 3. Incubation period: 13 to 14 days. Nestling period: 13 to 15 days (Newman 1958). Broods per year: 1. Age at sexual maturity: 1. Nest height: 8 to 20 feet (2.4 to 6 m).

NEST SITE: Usually suspended in hammock-like structure in the fork of a branch frequently near water (Godfrey 1979:255). Nests are often far out from the trunk and shaded (Harrison 1975:122).

FEEDING: Major foods: Moths, caterpillars, beetles, wasps, bees, and some wild berries (Terres 1980:381). Substrate: Air. Technique: Sallier.

REFERENCES: Godfrey 1979, Harrison 1975, Mumford 1964.


Alder Flycatcher

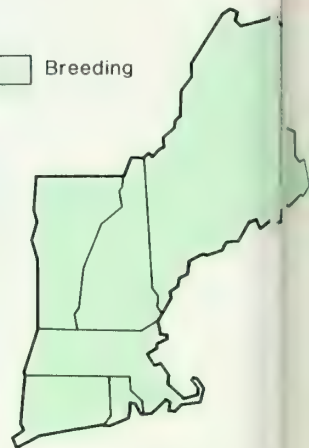
(*Empidonax alnorum*)

A.O.U. No. 466.3



Range

 Breeding



RANGE: Breeding: Newfoundland, w. to Alaska, s. to e. and n. Pennsylvania, c. Minnesota and c. British Columbia. Winter: Central and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (s. New England).

HABITAT: Breeding: Low, damp thickets bordering bogs, swamps and marshes. Often in alders, willows, elders, sumacs, viburnums. Prefers open areas.

SPECIAL HABITAT REQUIREMENTS: Areas with dense, low shrubs and clearings (edges).

NESTING: Egg dates: June 11 to July 29, New York (Bull 1974:376). Clutch size: 3 to 4. Incubation period: 12 to 14 days. Nestling period: 13 to 16 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 6 feet (0.3 to 1.8 m), typically 3 to 4 feet (0.9 to 1.2 m). Nest site: In low tree or shrub saddled on a branch or in an upright fork.

TERRITORY SIZE: Singing males of three separate populations had average territory sizes of 3.2, 3.8, 7.7 acres (1.2, 1.5, 3.1 ha) (Stein 1958).

FORAGING: Major foods: Flying insects. Substrate: Air. Techniques: Hawking, flight gleaning.

KEY REFERENCES: Bent 1942, King 1955, Stein 1958.


Willow Flycatcher

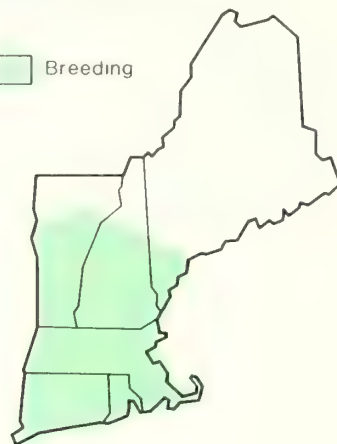
(*Empidonax traillii*)

O.U. No. 466.4



Range

 Breeding



RANGE: Breeding: Southern Main, w. to British Columbia, s. to n. Virginia, c. Arkansas and s. New Mexico. Winter: Central and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Prefers open, newly clearcut areas, up to dry brushy fields, woodland edges, hedgerows, roadsides, and orchards. Frequents uplands and lowlands.

SPECIAL HABITAT REQUIREMENTS: Low trees and shrubs with clearings (edges).

REPRODUCTION: Egg dates: June 11 to July 29, New York (Bull 194:376). Clutch size: 3 to 5, typically 3 or 4. Incubation period: 12 to 15 days. Nestling period: 15 to 18 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 3 to 25 feet (1.0 to 7.6 m). Typically 4 to 6 feet (1.2 to 1.8 m). Nest site: In a fork or saddled on a horizontal limb of a shrub, commonly willow, elder, viburnum, hawthorn, and others.

TERRITORY SIZE: 0.8 to 2.9 acres (0.3 to 1.2 ha) (average 1.2 acres (0.7 ha) for 73 territories in a dry marsh in Michigan (Walkinshaw 1966b). Singing males of three separate populations had average territory sizes of 2.6, 3.2, and 4.5 acres (1.1, 1.3, and 1.8 ha) (Stein 1958).

SAMPLE DENSITIES: 25 to 30 pairs per square mile (10 to 11 pairs/km²) in willow clump habitat in Illinois (8 to 9 birds per 100 acres (40 ha)) (Ford 1956 in Graber et al. 1974).

FORAGING: Major foods: Flying insects. Substrate: Air. Techniques: Hawking, flight gleaning.

COMMENTS: Difficult to distinguish from Alder Flycatcher (both formerly Traill's) even when in hand. Most widely accepted diagnostic characteristic is voice difference: Willow — "fitz-bew", Alder — "fee-beé-o".

KEY REFERENCES: Graber et al. 1974, King 1955, Stein 1958, Walkinshaw 1966b.

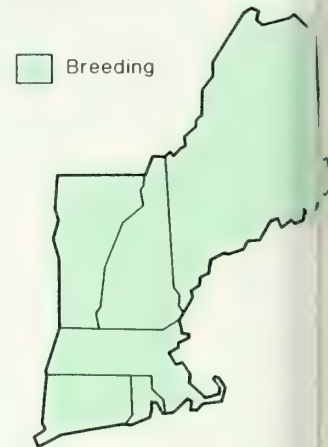
Least Flycatcher

(*Empidonax minimus*)

A.O.U. No. 467.0



Range



RANGE: Breeding: Nova Scotia to Mackenzie district, Northwest territories, s. to Long Island and central New Jersey and the mountains of Georgia, w. to Wyoming and British Columbia. Winter: Mexico and Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Deciduous forest edges, burns and clearings, open shrublands, orchards, well-planted residential areas, edges of country roads, overgrown pastures and open deciduous woodlands.

SPECIAL HABITAT REQUIREMENTS: Open deciduous forest, edge (shade for nest and open space for feeding), moderately vegetated woodlands (intermediate openness in understory) (Breckenridge 1956).

NESTING: Egg dates: May 16 to July 28. New York (Bull 1974:377). Clutch size: 3 to 6, typically 3 or 4. Incubation period: About 14 days. Nestling period: 14 to 16 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 2 to 60 feet (0.6 to 18.3 m), typically 10 to 20 feet (3.0 to 6.1 m). Nest site: In crotch or on limb of deciduous or coniferous tree. Known to nest in apple, oak, pine, willow, sugar maple, and others.

TERRITORY SIZE: 0.35 to 0.55 acre (0.1 to 0.2 ha) in oak-chestnut woodland in Virginia (Davis 1959). 0.03 to 0.5 acre (0.01 to 0.2 ha) (average 0.18 acre (0.07 ha)) in Michigan for 33 territories (MacQueen 1950). Usually less than 1 acre (0.4 ha) (Breckenridge 1956).

SAMPLE DENSITIES: 2 nests per 27.67 acres (11.2 ha) of residential woodland in Illinois (Beecher 1942 in Garner et al. 1974). 9 nests per 19 acres (7.7 ha) in Virginia (Davis 1959) — oak-chestnut woodland. 2.7 pairs per acre (0.4 ha) in aspen-birch-maple habitat in Michigan (MacQueen 1950).

FORAGING: Major foods: Flying insects. Substrate: n. Techniques: Hawking, flight-gleaning, gleaning.

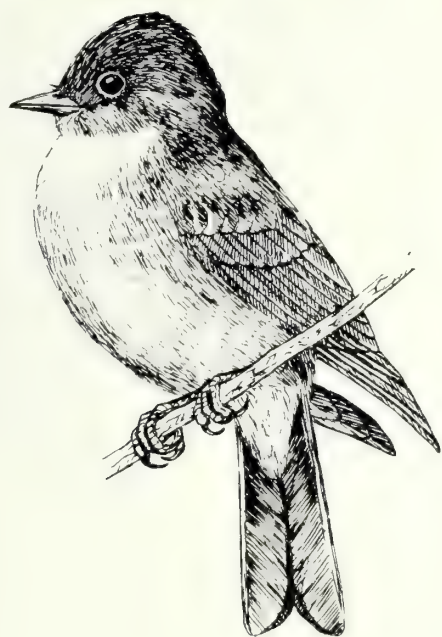
COMMENTS: Food studies have shown that Least flycatchers eat 98 percent animal and 2 percent vegetable material in summer (Beal 1912 in Bent 1942:218).

KEY REFERENCES: Bent 1942, Breckenridge 1956, Garner et al. 1974, MacQueen 1950.


Eastern Phoebe

(*Myiornis phoebe*)

O.U. No. 456.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. to Alaska, s. to n. Georgia (mountains) and e. New Mexico. Winter: Maryland s. Rarely to s. New England (coast) and Long Island.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Woodland cliffs, ravines, agricultural and suburban areas, often near streams.

SPECIAL HABITAT REQUIREMENTS: Perches 5 to 15 feet (1.5 to 4.6 m) high. Cliffs or ledges at stream-side clearings or man-made structures at forest openings (Hespenheide 1971).

REPRODUCTION: Egg dates: April 20 to August 4, New York (Bull 1936:369). Clutch size: 3 to 8, typically 5. Incubation period: 15 to 17 days. Nestling period: 15 to 17 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 2.5 to 20 feet (0.8 to 6.1 m), typically less than 15 feet (4.6 m). Nest site: On a ledge, usually sheltered by an overhang, often under leaves or on window sills, barn beams, bridge girders. Nest is frequently near water. Birds are very adaptable in nesting habits.

TERRITORY SIZE: 3.3 to 7.1 acres (1.3 and 2.9 ha) for 2 males nesting on buildings in Kansas (Fitch 1958). 0.7 acre (0.3 ha) in an Illinois floodplain forest (Fawver 1947 and Graber et al. 1974).

POPULATION DENSITIES: 6 nests per 30 acres (12.1 ha) in optimum habitat in Illinois (Graber et al. 1974). 7 pairs per

100 acres (40 ha) in mixed agricultural habitats in Maryland. 0.6 pairs per 100 acres (40 ha) in mixed forests and fields in Maryland (Stewart and Robbins 1958:201).

FORAGING: Major foods: Flying insects, occasionally small fruits. Substrate: Air. Technique: Hawking.

COMMENTS: Phoebes usually choose one or more favorite perches from which to hawk insects. They are common victims of cowbird parasitism. Blocher (1936) reported parasitism in 50 percent of the nests observed in Illinois. This species benefits from forest cuttings, moving into areas where cuttings have exposed ledge and rocks and creating sunny forest openings in the vicinity of ledge.

KEY REFERENCES: Bent 1942, Graber et al. 1974, Hespenheide 1971.


Great Crested Flycatcher

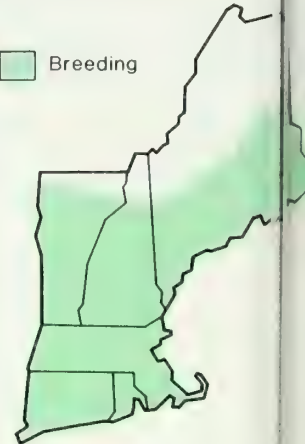
(*Myiarchus crinitus*)

A.O.U. No. 452.0



Range

 Breeding



RANGE: Breeding: New Brunswick, w. to se. Manitoba, s. to Florida and Texas. Winter: Southern Florida and s. Texas to n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Edges of deciduous or mixed woodlands, swamps, old orchards (with dead limbs or trees), woodland clearings, sometimes along sides of ravines, deep forests. Prefers forests with mature trees but also uses second-growth woodlands.

SPECIAL HABITAT REQUIREMENTS: Cavity for nesting (middle-aged to mature trees), deciduous forest, edge.

NESTING: Egg dates: May 22 to July 11, New York (Bull 1974:338). Clutch size: 4 to 8, typically 5 or 6. Incubation period: 13 to 15 days. Nestling period: 12 to 13 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 3 to 75 feet (0.6 to 22.9 m), typically 10 to 20 feet (3.0 to 6.1 m). Nest site: In a cavity in a live or dead tree; accepts nest boxes. Uses natural cavities or abandoned woodpecker holes.

TERRITORY SIZE: 0.6 to 4.6 acres (0.2 to 1.9 ha) (average 3.1 acres (1.3 ha)) for 26 territories in Illinois (Fawver 1947 in Graber 1974). 4 to 8 acres (1.6 to 3.2 ha) (Stewart and Robbins 1958). 7.2, 6.6, 5.6 acres (2.9, 2.7, 2.3 ha) in forest-field edge habitat in Kansas (Fitch 1958).

SAMPLE DENSITIES: 50 birds per 100 acres (40 ha) in suburban habitats in Illinois (Ridgeway 1915). 8 pairs per 100 acres (40 ha) in mixed oak forest in Maryland. 7 pairs

per 100 acres (40 ha) in dense second-growth oak saplings in Maryland. 4 pairs per 100 acres (40 ha) in hedgerows and active and abandoned farmland in Maryland (Stewart and Robbins 1958:200).

FORAGING: Major foods: Flying insects, insect larvae, fruits. Substrates: Air, crevices in bark of trees, cracks in fallen logs, leaf surfaces. Techniques: Hawking, glean- ing, hover-gleaning. Preferred feeding habitat: Forest canopy. Spend much time foraging in forest canopy.

COMMENTS: High foraging (canopy) is more prevalent with interior woodland nesters than with edge residents. Stomach analyses of 265 birds revealed a diet of 90 percent animal and 6 percent vegetable matter (Beal and Bent 1942:115). Originally a bird of forest interior, this flycatcher has broadened its habitat to include forest edge, open areas and forest edges (Bent 1942).

KEY REFERENCES: Allen 1933a, Bent 1942, Graber et al. 1974, Mousley 1934.

Eastern Kingbird

(*Tyrannus tyrannus*)

O.U. No. 444.0



Range



RANGE: Breeding: New Brunswick, w. to sw. British Columbia, s. to Florida, New Mexico, and Oregon. Winter: Central and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Frequently in orchards, pastures, shrubby borders, forest edges, along fields and highways, near streams with shrubby banks, swamps or marshes with dead stumps and snags, sometimes in open woodlands.

SPECIAL HABITAT REQUIREMENTS: Open situations, perches for flycatching.

REPRODUCTION: Egg dates: May 22 to July 16, New York (Bull 1913:364). Clutch size: 3 to 6, typically 3. Incubation period: 12 to 13 days. Nestling period: 13 to 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 60 feet (0.6 to 18.3 m), typically 10 to 20 feet (3.0 to 6.1 m). Nest site: Usually on a tree limb quite far from trunk and often over water. Less commonly nests in crotch or on top of dead stub. Apple is a preferred nest material.

TERRITORY SIZE: 14 to 35 acres (5.7 to 14.2 ha) (4 pairs) (Dum and Kuenzler 1955).

POPULATION DENSITIES: Approximately 2 to 9 birds per 100 acres (40 ha) in suitable habitat in Illinois (Graber et al. 1974). 36 pairs per square mile (4 pairs/km²) (maximum density) in North Dakota (Stewart and Kantrud 1972). 10 birds per 100 acres (40 ha) in residential-orchard-lawn habitat in Maryland (Stewart and Robbins 1958:198).

FORAGING: Major foods: Flying insects (staple), wild fruits; consumes over 200 kinds of insects and more than 40 kinds of fruits (Bent 1942). Substrate: Air. Techniques: Hawking, hovering, flight-gleaning; birds seem to have favorite hawking perches. Preferred feeding habitat: Over open land or water.

COMMENTS: Brewer (1958) found kingbirds nesting in young successional growth (6 to 20 years old) rather than older stands in strip-mining areas. Smith (1966) noted Kingbirds nesting in forested regions with internal clearings and extensive burned areas with standing trees.

KEY REFERENCES: Bent 1942, Graber et al. 1974, Johnston 1971.

Horned Lark

(*Eremophila alpestris*)

A.O.U. No. 474.0



Range

Permanent



RANGE: Breeding: Arctic North America, s. to n. South America. Winter: New Brunswick, w. to n. Minnesota and s. British Columbia, s. to Mexico and the Gulf States (rarely).

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common in summer and winter.

HABITAT: Breeding: Plowed fields and large open areas with closely cropped grasses, golf courses, athletic fields, cemeteries, airports, seashore. Prefers areas with a minimum of vegetation. Absent from wooded areas and high mountains. Wintering: Similar to breeding habitat. Concentrates on snowless wind-swept areas near coast where food is more accessible.

SPECIAL HABITAT REQUIREMENTS: Bare exposed earth within territory.

NESTING: Egg dates: February 28 to July 31, New York (Bull 1974:381). Clutch size: 3 to 5, typically 4. Incubation period: 11 days. Nestling period: 10 to 12 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest site: A hollow in ground, usually next to a tuft or dead of living grass or weeds. Nest is often paved with small pebbles along a portion of the rim.

TERRITORY SIZE: Approximately 0.8 ha (2 acres) on burned-over grassland in Evanston, Illinois (1 pair); 5.0 ha (approximately) in garden and grainfield for 1 pair in Ithaca, New York (Pickwell 1931:134). About 12 acres (4.9 ha) in field in Kansas (Fitch 1958).

SAMPLE DENSITIES: 6 pairs occupied 72 acres (29. a) field in Kansas (Fitch 1958). 160 pairs per square miles (pairs/km²) (maximum density) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FORAGING: Major foods: Summer — mainly insects. Winter — seeds of grasses and weeds, waste grains. Substrates: Bare earth, short grasses, and weeds. Techniques: Gleaning, scratching, running and pausing and pecking. Preferred feeding habitat: Snowless bare areas with abundant weed seeds in winter.

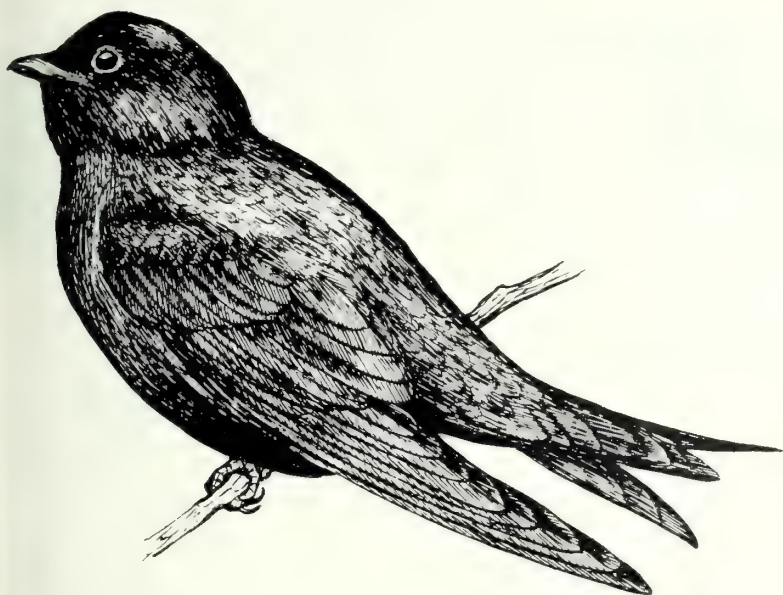
COMMENTS: Early eggs are occasionally destroyed by snowstorms. McAtee (1905 in Pickwell 1931:31) found that the vegetable portion of the diet taken in a year was counted for 79.4 percent of total. Birds are gregarious in winter.

KEY REFERENCES: Bent 1942, Pickwell 1931, Sutton 1927.

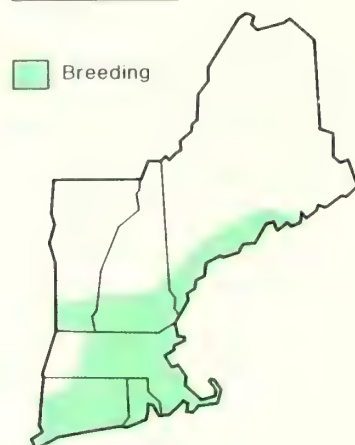
Purple Martin

(*Progne subis*)

C.O.U. No. 611.0



Range



RANGE: Breeding: Prince Edward Island, w. to s. British Columbia, s. to c. Mexico. Winter: Brazil.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common at local nest sites, rare elsewhere.

HABITAT: Breeding: Farmlands, parks, suburban yards, preferably near water.

SPECIAL HABITAT REQUIREMENTS: Large multi-roomed nest boxes, open space for foraging. May occasionally use natural cavities in trees.

REPRODUCTION: Egg dates: May 21 to July 13, New York (Bull 1974:390). Clutch size: 3 to 8, typically 4 or 5. Incubation period: 16 to 18 days. Nestling period: 26 to 31 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 15 to 20 feet (4.6 to 6.1 m). Nest site: Originally nested in cavities in trees; today nests almost exclusively in nest boxes, preferably near water. Birds favor large multi-roomed birdhouses set on poles 15 to 20 feet (4.6 to 6.1 m) high. Easily driven out of nest sites by starlings and house sparrows.

TERRITORY SIZE: Restricted to the nest cavity (Allen and Ne 1962).

SAMPLE DENSITIES: Colonies may consist of as many as 20 pairs (Bull and Farrand 1977).

FORAGING: Major foods: Flying insects. Substrate: Air. Techniques: Hawking, skimming water surface.

COMMENTS: In late summer, Martins gather in large flocks, often roosting in urban areas (Robbins et al. 1966) prior to their southward migration. Dependence on insects for food makes them vulnerable to starvation during long periods of cold, wet weather.

KEY REFERENCES: Allen and Nice 1952, Bent 1942, Finlay 1971.

Tree Swallow

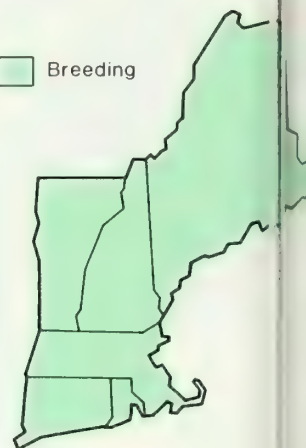
(*Tachycineta bicolor*)

A.O.U. No. 614.0



Range

 Breeding



RANGE: Breeding: Newfoundland w. to n. Alaska, s. to Maryland, Virginia, Colorado, and California. Winter: Coastal areas from Virginia, s. to Mexico, Central America and s. California. A few winter as far north as Long Island.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Farmlands, river bottomlands, beaver ponds, wooded swamps or marshes with dead standing trees in or near water. Competition for suitable natural cavities in the Northeast has resulted in the heavy use of nest boxes. Wintering: Tidewater areas with bayberries.

SPECIAL HABITAT REQUIREMENTS: Cavity for nesting. Open feeding areas such as meadows, marshes, or water. The minimum d.b.h. of suitable nest trees is 10 inches (25.4 cm) (Thomas et al. 1979).

NESTING: Egg dates: May 5 to June 29, New York (Bull 1974:382). Clutch size: 4 to 7, typically 5 or 6. Incubation period: 13 to 16 days. Nestling period: 16 to 24 days (depending on food supply). Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 4 to 15 feet (1.2 to 4.6 m). Nest site: Natural cavity or old woodpecker hole in a trunk or dead limb of dead or living tree, holes in buildings, nest boxes. Is usually a solitary nester but may nest in small groups where suitable cavities abound and there is a good food supply. Prefers to nest over a body of water.

TERRITORY SIZE: Territory is restricted to the nest site (Kuerzi 1941).

SAMPLE DENSITIES: 40 occupied nest boxes in 28 acres (11.3 ha) of modified woodland in Illinois (Becher 1942). Birds will nest within 7 feet (2.1 m) of each other in the presence of abundant food (Scott et al. 1977). Densities of up to 150 pairs per 0.3 ha (0.7 acres) are possible in nest boxes spaced no less than 2 m (6.6 feet) apart (Whittle 1926).

FORAGING: Major foods: Flying insects (summer berries, and seeds are taken to supplement the winter diet when insects are less abundant. Substrates: Air, water. Techniques: Hawking, skimming water surface. Preferred feeding habitat: Over bodies of water.

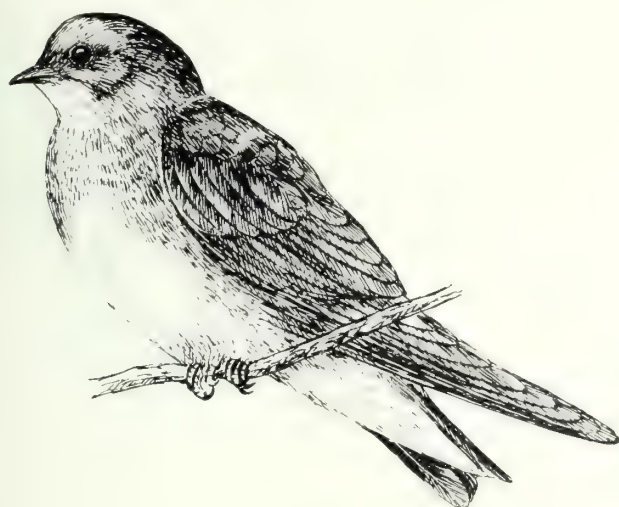
COMMENTS: The Tree Swallow's habit of eating berries enables it to return to the Northeast earlier in the spring, linger later in fall, and remain farther south in winter than other species of swallows. It commonly occurs in large coastal flocks in autumn.

KEY REFERENCES: Chapman 1955, Graber et al. 1972, Kuerzi 1941, Paynter 1954.

Northern Rough-winged Swallow

(*Hirundo erythrogastra*)

O.U. No. 617.0



Range

 Breeding



RANGE: Breeding: Maine to New Brunswick w. to British Columbia, s. to South America. Winter: Mexico to South America. Occasionally n. to coastal South Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Nearly any open area with adequate nest sites and a water supply (usually a stream). Often river valleys and lake shores.

NESTING: Egg dates: May 19 to July 5, New York (Bull 1974:385). Clutch size: 4 to 8, typically 6 or 7. Incubation period: 16 days. Nestling period: 20 to 21 days, to 30 days where food is scarce. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Solitary or semi-colonial nester (colonies usually consist of 2 to 6 pairs). Nests in burrows in sandy banks, often along a stream, irrigation ditch, and less commonly in rock ledges, crevices in bridges and buildings, or drainage pipes under bridges. Often occupies abandoned bank swallow or Kingfisher holes.

TERRITORY SIZE: Territory is limited to the immediate vicinity of the nest entrance (Lunk 1962:29).

FEEDING: Major foods: Flying insects. Substrate: Air. Techniques: Hawking, skimming water surface.

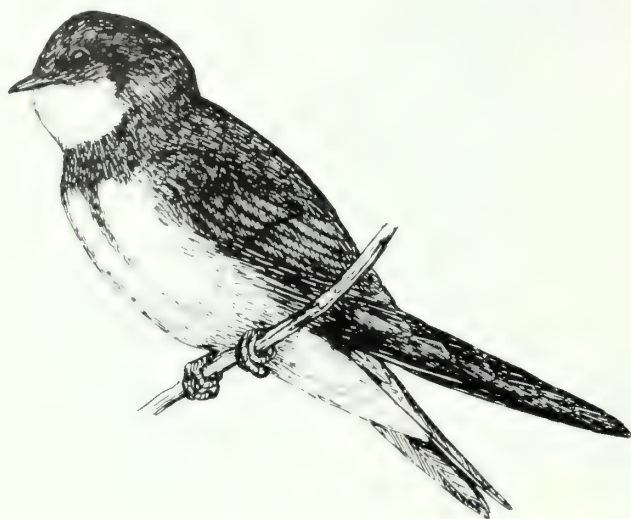
COMMENTS: Often one or a very few pairs of Rough-wings share a bank with Bank Swallows, especially along major water courses.

KEY REFERENCES: Bent 1942, Graber et al. 1972, Lunk 1962.

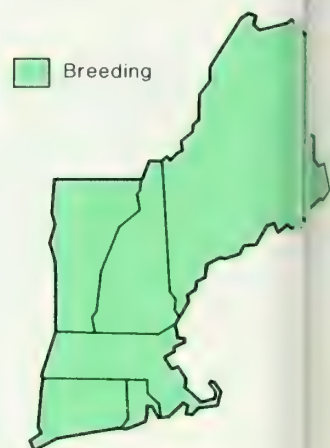
Bank Swallow

(*Riparia riparia*)

A.O.U. No. 616.0



Range



RANGE: Breeding: Labrador, w. to Alaska, s. to Virginia and the Carolinas (mountains), s. Texas and s. California. Winter: South America, mainly in Brazil.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon depending on availability of nest sites.

HABITAT: Breeding: Riverbanks, gravel pits, road cuts, hardened sawdust piles, and clay banks. Prefers areas with grassland or cultivated fields at low elevations and near fresh water.

SPECIAL HABITAT REQUIREMENTS: Sand or clay banks that are stabilized by a grassy mat overhanging the top.

NESTING: Egg dates: May 15 to July 13 (second brood), New York (Bull 1974:383). Clutch size: 4 to 6, typically 5. Incubation period: 14 to 16 days. Nestling period: 18 to 22 days, to 30 days where food supply is limited. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: A burrow dug by both sexes usually near top of bank. Depth varies from 9 inches (22.9 cm) to 6 feet (1.6 m). Birds may restore existing burrows and form dense colonies where possible.

TERRITORY SIZE: Territory is restricted to the area immediately surrounding the nest site.

SAMPLE DENSITIES: Minimum spacing of nest holes in a Wisconsin study was 4 inches (10.2 cm). Most holes were 5 to 7 inches (12.7 to 17.8 cm) apart (Petersen 1955).

FORAGING: Major foods: Flying insects (nearly 100 percent of diet). Substrate: Air. Techniques: Hawking, skimming water surface. Preferred feeding heights: Over water or grasslands, especially pastures.

COMMENTS: Colonial feeding may be an adaptation that allows for more effective discovery of insect swarms. Birds typically nest in dense colonies of 10 to more than 300 nests. Nesting is synchronized — more than 70 percent of the young leave the nest within a 6-day period (Emlen and Demong 1974).

KEY REFERENCES: Bent 1942, Beyer 1938, Graber et al. 1972, Petersen 1955.


Cliff Swallow

(*irundo pyrrhonota*)

O.U. No. 612.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. to n. Alaska, s. to Virginia, Missouri and Central America. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Farmlands, villages, cliffs, bridges, dams, fresh or salt water areas, open forests.

SPECIAL HABITAT REQUIREMENTS: Open foraging areas, vertical wall with an overhang for nest attachment, mud for nest construction, fresh water with smooth surface for drinking. Nesting success is higher when house sparrows are controlled at colonies.

REPRODUCTION: Egg dates: May 9 to July 14, New York (Bull 1974:389). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 15 to 16 days. Nestling period: About 24 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: Nests colonially under bridges or dams, eaves, and interior of barns and sheds. Solitary nesting occasionally occurs.

TERRITORY SIZE: Restricted to the distance the bird can reach with bill from rim of nest (Emlen 1952).

POPULATION DENSITIES: More than 100 nests have been counted at a single barn (Bull 1974:389).

FEEDING: Major foods: Flying insects make up nearly 100 percent of diet (Bent 1942:476). Substrate: Air.

Techniques: Hawking, skimming water surface. Preferred feeding habitat: Often feed high in the sky (in excess of 100 feet) (30.5 m). Birds were seen feeding up to 4 miles (6.4 km) from nest site (Emlen 1954).

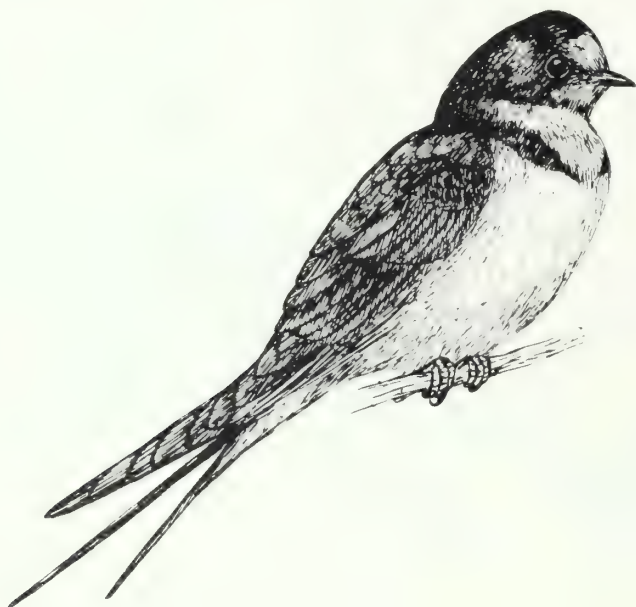
COMMENTS: Cliff and barn swallows may nest in the same barn, but competition is minimal because Cliff Swallows build near the entrance point and Barn Swallows nest deeper in the interior (Samuel 1971). Much of Cliff Swallow habitat has been usurped by House Sparrows.

KEY REFERENCES: Emlen 1952, 1954; Graber et al. 1972, Mayhew 1958, Samuel 1971.


Barn Swallow

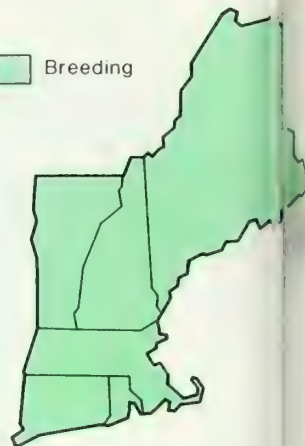
(*Hirundo rustica*)

A.O.U. No. 613.0



Range

 Breeding



RANGE: Breeding: Labrador, west to Alaska, south to Georgia, Alabama, and Mexico. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Farmlands, rural and abundant areas.

SPECIAL HABITAT REQUIREMENTS: Man-made structures, especially buildings, for nesting. Open barns with suitable areas for nest construction on beams.

NESTING: Egg dates: May 11 to August 3, New York (Bull 1974:366). Clutch size: 4 to 6, typically 4 or 5. Incubation period: About 15 days. Nestling period: 16 to 23 days. Broods per year: 1 or 2 (at warmer latitudes). Age at sexual maturity: 1 year. Nest site: Nests inside sheds and barns (often in colonies), under bridges, culverts. Formerly nested on cliffs, in caves and in niches in rocks.

TERRITORY SIZE: Probably restricted to the nest site.

SAMPLE DENSITIES: Usually 6 to 8 nests per site is maximum, but as many as 55 nests have been reported in a single barn (Harrison 1975:132) and 63 at a Lunenburg, Massachusetts barn (Blodget, personal communication). 20 pairs per square mile (8 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 11 pairs per 100 acres (40 ha) in mixed agricultural and residential habitats including buildings (Stewart and Robbins 1958:214).

FORAGING: Major foods: Flying insects, occasionally takes fruits. Substrate: Air. Techniques: Hawking, skimming water surface. Preferred feeding habitat: Over ponds, lakes, rivers, and fields, seldom feeds more than 0.5 mile (0.8 km) from nest site (Samuel 1971).

COMMENTS: The diet consists almost entirely of aerial matter (Bent 1942:450). Nearly all the food is taken on the wing. Swallows in Illinois spent much time feeding over edge shrub areas. Feeding densities averaged 26 birds per 100 acres (40 ha) (Graber et al. 1972).

KEY REFERENCES: Bent 1942, Davis 1937, Graber et al. 1972, Samuel 1971.

Gray Jay

Perisoreus canadensis)

.O.U. No. 484.0



Range

Permanent



RANGE: Breeding: Labrador, w. to n. Alaska, s. to n. New England, New York (Adirondacks), Michigan, and California. Winter: Same as breeding range, however, birds may wander as far s. as Pennsylvania and the s. Great Plains.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Coniferous forest and nearby deciduous or mixed woodlands. Coniferous swamps, wooded mountain slopes. Wintering: Birds wander but seldom move south of the breeding range. In mountainous areas, they commonly seek lower elevations.

SPECIAL HABITAT REQUIREMENTS: Coniferous forests.

REPRODUCTION: Egg dates: March to April (Goodwin 196:250). Clutch size: 2 to 5, typically 3 or 4. Incubation period: 16 to 18 days. Nestling period: About 15 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 5 to 30 feet (1.5 to 9.1 m), typically 5 to 12 feet (1.5 to 3.7 m). Nest site: In solitary tree or clump of trees, usually conifers. Nest is often placed in crown of low tree or lower near trunk or branch tips and is usually well hidden.

FORAGING: Major foods: Insects, fruits, seeds, buds. Substrates: Leaf litter on ground, leaf and branch surfaces of trees and shrubs. Techniques: Gleaning.

COMMENTS: Gray Jays cache food for future use.

KEY REFERENCES: Bent 1946, Goodwin 1976, Lawrence 1947.



Blue Jay

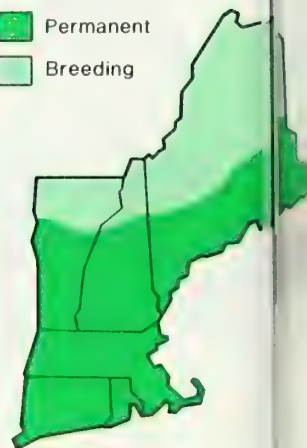
(*Cyanocitta cristata*)

A.O.U. No. 477.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland w. to s. Alberta, s. to Florida and Texas. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Coniferous, deciduous, and mixed (preferred) woodlands representing a variety of forest types, wooded islands, farms, cities, suburbs, parks, and gardens. Prefers woodlands of oak, beech, and hickory. Wintering: Some northern birds move to more southern parts of breeding range (Goodwin 1976:263).

NESTING: Egg dates: April 28 to June 17, New York (Bull 1974:393). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 17 to 18 days. Nestling period: 17 to 21 days. Broods per year: 1 north, 2 south. Age at sexual maturity: 2 years (occasionally 1 year). Nest height: 5 to 50 feet (1.5 to 15.2 m), typically 10 to 25 feet (3.0 to 7.6 m). Nest site: Prefers to nest in conifer thickets in mixed woodlands. Also builds in deciduous trees, shrubs, and shrubs overrun with vines. Nest may be close to trunk of tree or well out on a horizontal limb.

TERRITORY SIZE: Territorial boundaries are not well defined (Goodwin 1976:267).

SAMPLE DENSITIES: 5 birds per 100 acres (40 ha) in well-defined floodplain forest in Maryland. 4 birds per 100 acres (40.5 h) in mixed-oak forest in Maryland (Stewart and Robbins 1958).

FORAGING: Major foods: Seeds, fruits, mast, occasionally takes insects, nestlings, young mice. Acorns are a staple food item throughout the year. Substrates: Ground (litter), tree tops, shrubs; birds feed at all levels in vegetation. Techniques: Hopping and gleaning.

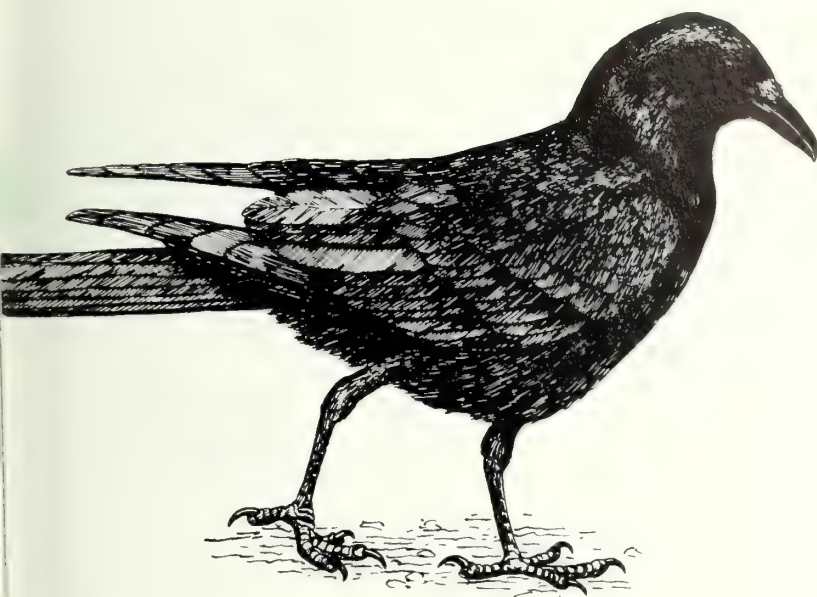
COMMENTS: Beal (1897 in Bent 1946:39) found that 76 percent of the annual diet (292 stomachs taken throughout the year) was vegetable matter and 24 percent was animal matter. Birds cache food in various places, possibly for winter use.

KEY REFERENCES: Bent 1946, Goodwin 1976.

American Crow

Corvus brachyrhynchos)

O.U. No. 331.0



Range

- Permanent
- Breeding



RANGE: Breeding: Newfoundland, w. to British Columbia, s. to Florida, the Gulf Coast and s. California. Wintering: Southern Canadian Provinces, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Interior and edges of open deciduous, coniferous, and mixed forests and woodlots. Prefers woodland with adjacent farmland. Wintering: Large flocks often aggregate in coastal areas where food is more accessible.

REPRODUCTION: Egg dates: March 30 to June 14, New York (Bull 194:397). Clutch size: 3 to 8, typically 4 to 6. Incubation period: 18 days. Nestling period: About 25 days. Broods per year: 1 north, often 2 in south (Harrison 1975:139). Age at sexual maturity: 2 years. Nest height: 10 to 70 feet (3 to 21 m). Nest site: Usually in crotch of tree near trunk or on a horizontal limb. Prefers to nest in conifers when available.

TERRITORY SIZE: Fitch (1958) found crows nonterritorial in Kansas and highly social in many activities.

SAMPLE DENSITIES: 0.6 pair per 100 acres (40 ha) in mixed woodland and farmland habitat in Maryland (Stewart and Robbins 1958). 4 pairs nested within a distance of 10 yards (9.1 m) in Kansas (Fitch 1958). 8 pairs per square mile (3 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

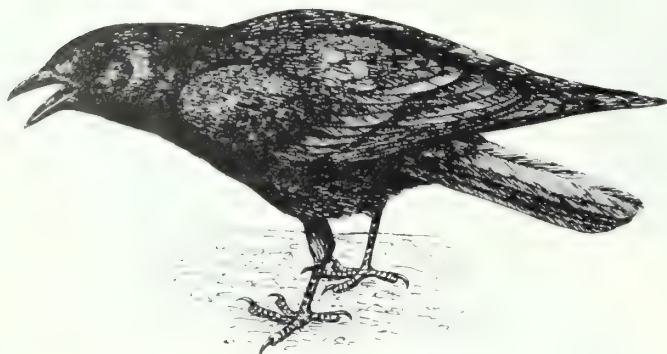
FORAGING: Major foods: Crows are omnivorous, taking mammals (mainly carrion), insects, small birds (nestlings), fruit, garbage, grain. Substrates: A variety of substrates. Techniques: Aerial searching, followed by quick descent to ground. Preferred feeding habitat: Cultivated grain fields.

KEY REFERENCES: Bent 1946, Goodwin 1976, Johnston 1961.

Fish Crow

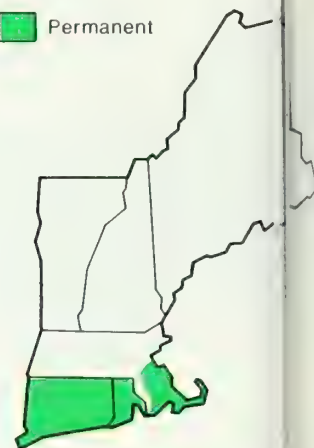
(*Corvus ossifragus*)

A.O.U. No. 490.0



Range

 Permanent



RANGE: Breeding: Atlantic coast from Massachusetts s. to Florida, w. along the Gulf Coast to e. Texas. Winter: New York, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Low coastal areas especially wooded marine shorelines, coastal marshes and beaches and inland wetlands, especially along rivers affected by tides. Wintering: Same as breeding habitat.

NESTING: Egg dates: March 20 to June 5, New York (Bull 1974:399). Clutch size: 4 to 5. Incubation period: 17 to 18 days. Nestling period: About 21 days. Broods per year: 1. Age at sexual maturity: 2 years. Nest height: 20 to 80 feet (6.1 to 24.4 m), typically 50 feet (15.2 m). Nest site: Usually in small colonies in deciduous or coniferous trees.

SAMPLE DENSITIES: Colonies usually are made up of 2 to 4 pairs each nesting in a separate tree.

FORAGING: Major foods: Insects, grain wild fruits, aquatic organisms, birds' eggs, carrion. Substrates: Mud, sand, water, other birds' nests. Techniques: Hovering, followed by quick descent to food, ground-gleaning. Preferred feeding habitat: Tidal flats, beaches, rookeries, banks of brackish rivers.

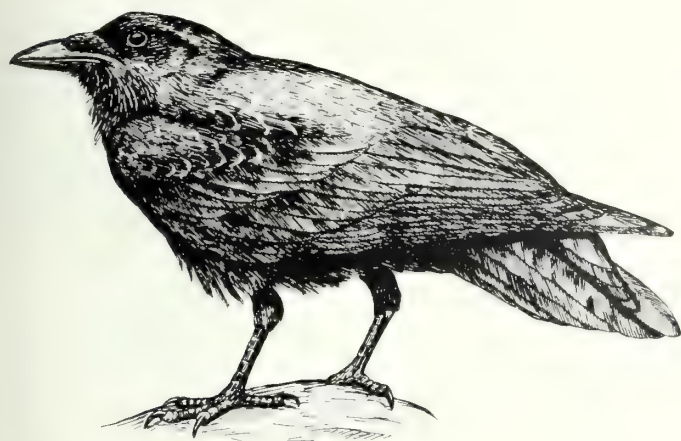
COMMENTS: Also breeds in fertile farmland well inland from coast (100+ miles (16.0+ km)) in Pennsylvania and Maryland. Fish crows often feed and roost in large flocks with common crows.

KEY REFERENCES: Bent 1946, Forbush 1929, Gowwin 1976.

Common Raven

(*Corvus corax*)

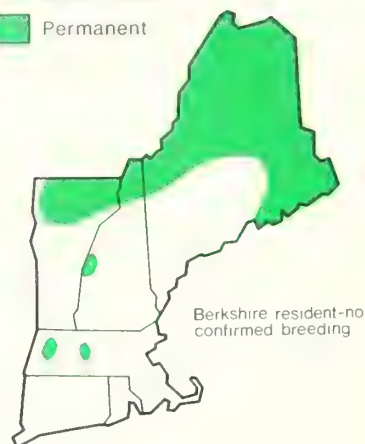
O.U. No. 486.0



Range



Permanent



RANGE: Breeding: Northern North America, s. to coastal line, the Dakotas, and the mountains to Georgia and Central America. Local in Adirondack Mountains. Winter: Some birds move to more southern parts of breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Laine).

HABITAT: Breeding: Remote mountain forests, seacoasts, wooded marine islands. Prefers open woodlands, clearings; avoids extensive, dense forests. Wintering: Ravens commonly move toward the coast or to southern parts of breeding range where foods is more accessible. Lake shores, rivers banks, mud flats.

SPECIAL HABITAT REQUIREMENTS: Cliffs or tall trees for nesting.

NESTING: Egg dates: March 24 to April 29, Maine (Bent 196:214). Clutch size: 3 to 6, typically 4 or 5. Incubation period: About 21 days. Nestling period: About 40 days. Broods per year: 1. Age at sexual maturity: Probably 3 or more years (Hooper and Dachelet 1976). Nest site: Usually on a cliff or high in a coniferous tree. Ravens in Virginia nested on cliffs with an overhang above and a steep rock face below. Nests were found as close as 0.5 mile (0.8 km) to human dwellings (Hooper 1977).

HOME RANGE: 2.6 to 4.2 square miles (6.7 to 10.9 km²) (observed areas) in Wyoming (Craighead and Craighead 1969). Hooper (1977) observed ravens flying more than 1.2 miles (2 km) from nest sites.

SAMPLE DENSITIES: Nests are often spaced several miles apart (Harrison 1975). Hooper and others (1975) found ravens nesting as close as 2.2 km (1.4 miles) and with an average distance of 4.3 km (1.7 miles).

FORAGING: Major foods: Ravens are omnivorous, taking small to large mammals (carrion), birds, insects and plant material (Harlow et al. 1975). Substrates: Lake shores, mud flats (coast), forest floor. Technique: Scavenging. Preferred feeding habitat: Seabird colonies (coast), garbage heaps; highways (road kills).

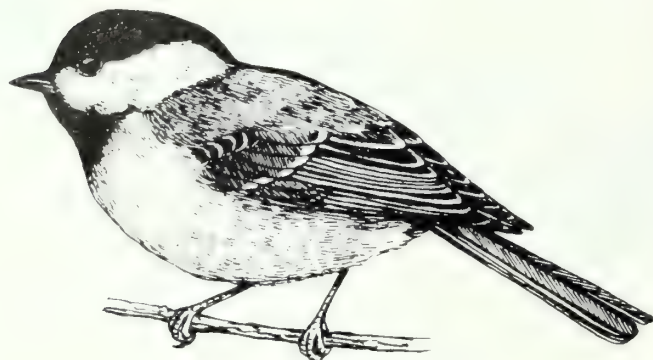
COMMENTS: Harlow and others (1975) found that medium to large mammals were the predominant food items taken in winter and spring in Virginia. They were apparently in the form of carrion supplied by road kills or natural mortality.

KEY REFERENCES: Bent 1946, Goodwin 1976, Harlow 1922, Hooper 1977, Murray 1940, Tyrrell 1945.

Black-capped Chickadee

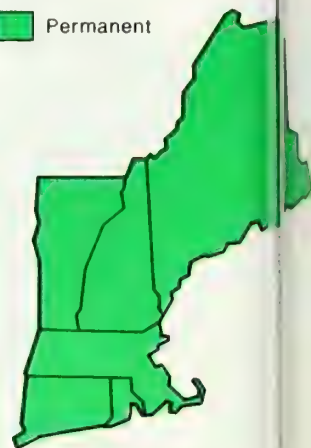
(*Parus atricapillus*)

A.O.U. No. 735.0



Range

Permanent



RANGE: Breeding: Newfoundland, w. to c. Alaska, s. to North Carolina (mountains), n. New Mexico and n. California. Winter: Resident in breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Deciduous, coniferous, or mixed woodlands (mixed preferred). Frequents both heavily forested and residential areas. Wintering: Frequents city parks and residential areas with feeding stations adjacent to breeding habitat. Birds generally remain in breeding areas.

SPECIAL HABITAT REQUIREMENTS: Require dead standing trees (minimum d.b.h. 4 inches (10.2 cm)) for excavating cavities or trees with existing cavities for nesting (Thomas et al. 1979). Comparatively open situations (nesting) near deeper woods (feeding) (Odum 1941).

NESTING: Egg dates: April 29 to July 15, New York (Bull 1974:401). Clutch size: 5 to 10, typically 6 to 8. Incubation period: 12 to 13 days. Nestling period: About 16 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 1 to 50 feet (0.3 to 15.2 m), typically 4 to 10 feet (1.2 to 3.0 m). Nest site: In a cavity in a standing dead tree or stub, preferably birch, aspen, pin cherry, or other tree that undergoes rapid decay. Accepts nest boxes. Prefers stubs with firm shells and decayed interiors (Brewer 1961). Usually excavated in decaying wood. Rarely uses old woodpecker holes and natural cavities.

TERRITORY SIZE: Sizes ranged from 8.4 to 17.1 acres (3.4 to 6.9 ha) (average 13.2 acres (5.3 ha)) in different habitats (Odum 1941). 2.3 acres (0.9 ha) for 1 pair in Kansas (Fitch 1958).

HOME RANGE: Winter — approximately 21 to 55 acres (8.5 to 22.3 ha) (average 36 acres (14.6 ha)) in New York (Odum 1942:523). 19.1 acres (7.7 ha) in Kansas (Fitch 1958).

SAMPLE DENSITIES: Average 1 pair per 22 acres (8.9 ha) in suitable habitat (Odum 1941). Winter—1 bird per 66 acres (1.1 ha) in bottomland woods in New York (Harris 1931). Maximum 27 pairs per 40 ha (100 acres) (Harris and Evans 1977).

FORAGING: Major foods: Insects, seeds, fruits. Substrates: Bark crevices; leaf, branch, and twig surfaces. Techniques: Gleaning, probing of tree trunk, branches, leaves. Preferred feeding habitat: Chickadees feed where food is most abundant. Kluyver (1961) found that birds fed more often in pine groves with abundant caterpillars than in adjacent oak woods.

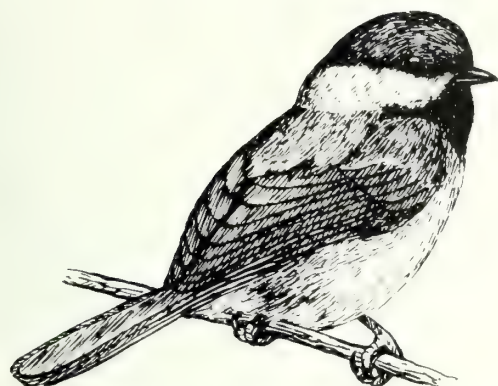
COMMENTS: A study by Odum (1941) revealed that nests were often located in open woods or forest edge and feeding was heaviest in deep woods.

KEY REFERENCES: Brewer 1961; Kluyver 1961; Cummins 1941, 1942.

boreal Chickadee

(*Parus hudsonicus*)

O.U. No. 740.0



Range

 Permanent



RANGE: Breeding: Labrador, w. to nw. Alaska, s. to Maine, n. New York and s. British Columbia. Winter: Same as breeding range. Wanders to se. New York and New Jersey.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) and rare (Massachusetts).

HABITAT: Breeding: Northern coniferous woods, wooded swamps, bogs. Wintering: Same as breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Decaying trees for excavating cavities. McLaren (1975) found that Chickadees preferred to nest in trees with soft wood and hard exterior layers and bark.

NESTING: Egg dates: June 11 to July 17 (late), New York (Hall 1974:402). Clutch size: 4 to 9, typically 6 or 7. Incubation period: 12 to 13 days (Harrison 1975). Nestling period: About 18 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 10 feet (0.3 to 3.0 m). Nest site: Decaying stub or tree, preferably with firm exterior and soft interior. Bird may excavate several holes before choosing one for nest. Sometimes uses natural cavities or old woodpecker holes.

TERRITORY SIZE: Larger than 5 ha (12.4 acres) in spruce-fir forest (McLaren 1975).

FEEDING: Major foods: Insects, seeds, fruits. Substrates: Bark crevices, leaves, twigs, branches. Techniques: Gleaning, probing of tree trunk, branches, needles, cover.

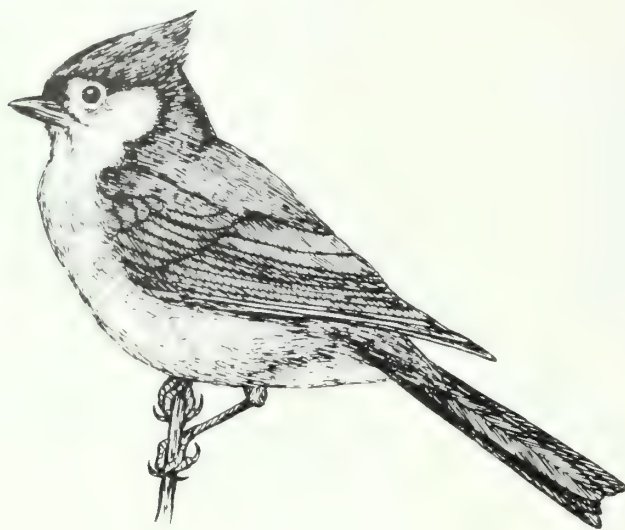
COMMENTS: Nest site selection seems to be influenced more by the softness of the wood than by species of tree (McLaren 1975).

KEY REFERENCES: Bent 1946, Forbush 1929, McLaren 1975.

Tufted Titmouse

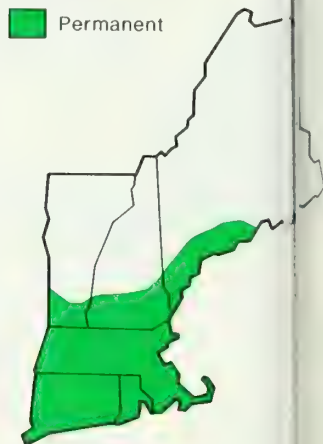
(*Parus bicolor*)

A.O.U. No. 731.0



Range

Permanent



RANGE: Breeding: Central New England, w. to Illinois and n. Nebraska, s. to Florida, the Gulf Coast and Texas. Increasing and spreading n. in the Northeast. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common except at limits of range.

HABITAT: Breeding: Low rich woodlands, moist bottomlands and swamps, residential areas in shade trees. Wintering: Same but with preference for feeding stations.

SPECIAL HABITAT REQUIREMENTS: Nesting cavities, commonly in mixed woods.

NESTING: Egg dates: April 29 to May 27, New York (Bull 1974:404). Clutch size: 4 to 8, typically 5 or 6. Incubation period: 12 days. Nestling period: 15 to 18 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 3 to 90 feet (0.9 to 27.4 m). Nest site: A natural tree cavity or old woodpecker hole. It is generally believed that Tufted Titmice do not excavate their own nest sites. Accepted nest boxes.

TERRITORY SIZE: 2.9 acres (1.2 ha) in oak-hickory-elm habitat in Kansas (Fitch 1958).

HOME RANGE: 5 birds were repeatedly recorded year-round within a 0.6 mile (0.9 km) radius from a banding station in Michigan (Van Tyne 1948). Average sizes of minimum home ranges in winter ranged from 10.4 to 19.7 acres (4.2 to 8.0 ha) in Kansas (Fitch 1958).

SAMPLE DENSITIES: Maryland—13 pairs per 100 acres (40 ha) in well-drained floodplain forest. 13 pairs per 100 acres (40 ha) in upland oak forest. 11 pairs per 100 acres (40 ha) in second-growth river swamp. 6 pairs per 100 acres (40 ha) in pine-oak forest (Stewart and Robbins 1958:226).

FORAGING: Major foods: Insects, seeds, and fruits, especially mast. Substrates: Branch and leaf surfaces (spring and summer), branch surfaces (winter); ground, especially exposed soil (Fitch 1958). Techniques: Gleaning, probing. Preferred feeding habitat: Often in canopy but very frequently near the ground when not disturbed by observers.

COMMENTS: Pairs may mate for life (Gillespie 1930). Bent (1916 in Bent 1946:399) found the food of 186 birds consisted of 67 percent animal and 33 percent vegetable matter. May have extended its range in the Northeast due to reduced winter mortality due to suburban feeding stations.

KEY REFERENCES: Bent 1946, Boyd 1962, Forbush 1939, Gillespie 1930, Laskey 1957.

Red-breasted Nuthatch

Sitta canadensis)

O.U. No. 728.0



Range



RANGE: Breeding: Newfoundland, w. to Alaska, s. to New Jersey, North Carolina (mountains) and s. California. Winter: Northern United States, irregularly s. to Florida, the Gulf Coast and n. Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine).

HABITAT: Breeding: Coniferous forests, sometimes in mixed woodlands. Wintering: Mainly coniferous forests but also frequents mixed woodlands with cone-bearing trees. Less often in deciduous woods (winter only).

SPECIAL HABITAT REQUIREMENTS: Coniferous woods, cavity for nesting in tree with minimum d.b.h. of 12 inches (30.5 cm) (Thomas et al. 1979).

REPRODUCTION: Egg dates: April 13 to June 17, New York (Bull 1974:409). Clutch size: 4 to 7, typically 5 or 6. Incubation period: 12 days. Nestling period: 21 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 5 to 4 feet (1.5 to 12.2 m), typically 15 feet (4.6 m). Nest site: Cavity in a rotted stub or dead branch, usually excavated but occasionally uses an old woodpecker hole.

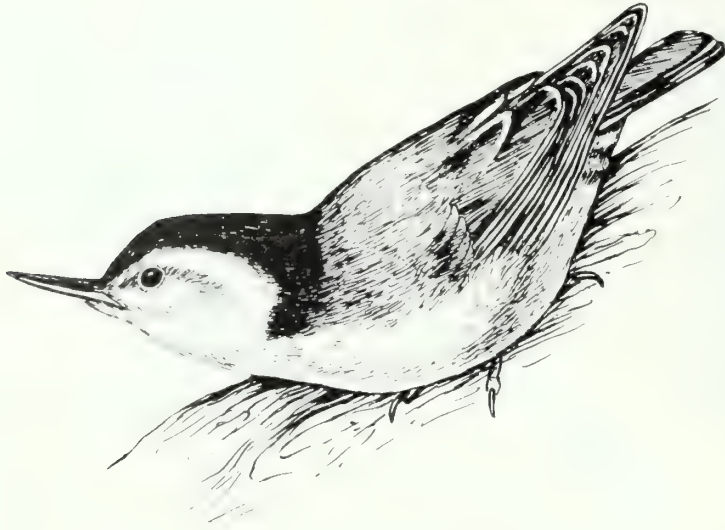
FEEDING: Major foods: Small insects, seeds—especially of pine, spruce and fir. Substrates: Mainly along twigs and small branches (Bull 1974:409). Techniques: Pecking, probing.

KEY REFERENCES: Bent 1948, Lawrence 1952.

White-breasted Nuthatch

(*Sitta carolinensis*)

A.O.U. No. 727.0



Range



Permanent



RANGE: Breeding: Southern Quebec, w. to s. British Columbia, s. to Florida and Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Mixed or deciduous woodlands with large trees, orchards, villages. Wintering: Birds tend to remain in breeding areas.

SPECIAL HABITAT REQUIREMENTS: Natural cavities for nesting. Trees with minimum d.b.h. of 12 inches (30.5 cm) (Thomas et al. 1979) are most suitable.

NESTING: Egg dates: April 3 to June 6, New York (Bull 1974:407). Clutch size: 5 to 9, typically 8. Incubation period: 12 days. Nestling period: About 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 15 to 50 feet (4.6 to 15.2 m). Nest site: Cavity in a live, dead, or dying tree at almost any height above ground. Seems to prefer rotted out knot holes or similar natural openings to old woodpecker holes (Pough 1949:95). Rarely, if ever, excavates own cavity. Much competition for natural cavities occurs between White-breasted Nuthatches and gray and red squirrels (Kilham 1968b).

TERRITORY SIZE: Winter feeding territories ranged from 25 to 30 acres (10.1 to 12.1 ha) per pair in woodlands and about 50 acres (20.2 ha) per pair in semiwooded country (Butts 1931).

SAMPLE DENSITIES: 1 pair per 24 acres (9.6 ha) in New York (Butts 1931). 6 pairs per 100 acres (40 ha) in tulip-poplar forest in Maryland. 5 pairs per 100 acres (40 ha) in semi-open floodplain forest (sycamore, ash, etc.) in Maryland (Stewart and Robbins 1958:228).

FORAGING: Major foods: Insects, seeds, fruits, mast. The main summer diet consists of gypsy moth larvae and tree caterpillars, beetles, spiders, and ants (Hardin and Evans 1977). Substrates: Trunks and larger branches of trees, bark crevices. Techniques: Gleaning, probing. Preferred feeding habitat: Often uses feeding stations, especially in winter.

COMMENTS: The spring diet consists of more than 79 percent insects. The winter diet contained 26 percent animal and 67 percent vegetable (Forbush 1929). Birds commonly store food in crevices of bark (Kilham 1974).

KEY REFERENCES: Bent 1948, Butts 1931, Forbush 1929, Kilham 1968b.

Brown Creeper

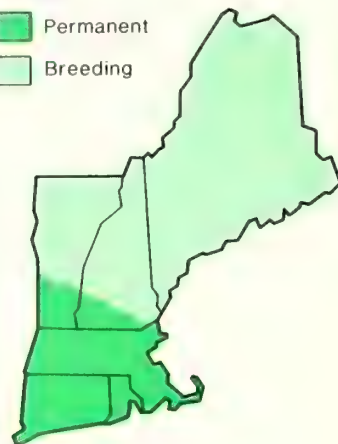
(*Merula americana*)

O.U. No. 726



Range

- Permanent
- Breeding



DISTRIBUTION: Breeding: Nova Scotia, w. through the s. Canadian provinces to Alaska, s. to Maryland (locally), the mountains of North Carolina and the Rockies. Winter: Northern United States, s. to Florida, the Gulf Coast, and Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common in the Adirondacks; common elsewhere.

HABITAT: Breeding: Dense coniferous, deciduous, or mixed woodlands, wooded swamps. Wintering: Same as breeding. Birds retreat to lower altitudes.

NESTING HABITAT REQUIREMENTS: Standing dead trees with loose bark. The minimum d.b.h. of suitable nest trees is 10 inches (25.4 cm) (Thomas et al. 1979).

REPRODUCTION: Egg dates: April 24 to June 30, New York (Bull 1942). Clutch size: 5 to 9, typically 5 or 6. Incubation period: 14 to 15 days. Nestling period: 13 to 15 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 5 to 15 feet (1.5 to 4.6 m). Nest site: Low on trunk of coniferous or deciduous tree under a strip of loose bark, less often in a rotted knothole or old woodpecker cavity (probably only when loose bark is unavailable).

FORAGING: Major foods: Insects; a small amount of vegetable material, mainly mast. Substrates: Bark crevices, trunk, sides and undersides of limbs. Techniques: Gleaning, probing, scaling. Preferred feeding habitat: Bark crevices. Sometimes attracted to suet at feeding stations in winter.

KEY REFERENCES: Bent 1948, Forbush 1929.

Carolina Wren

(*Thryothorus ludovicianus*)

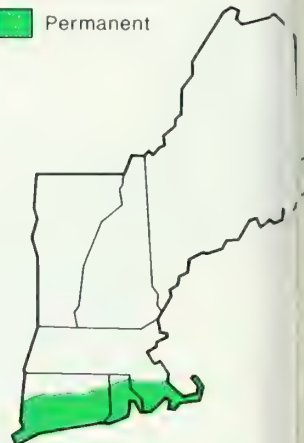
A.O.U. No. 718.0



Range



Permanent



RANGE: Breeding: Southern New England, c. New York (except mountains), w. to se. Wisconsin and Iowa, s. to the Gulf Coast and Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare (Massachusetts).

HABITAT: Breeding: A variety of places from lowland stream bank tangles to upland brushy slopes, woodland edges, slash piles, vicinity of buildings. Prefers moist areas. Wintering: Low, flat ground near tidewater creeks (New Jersey—Bent 1948). Narrow Valleys and deep ravines in parts of winter range. Trautman (1940) observed wrens in Ohio that moved from partly exposed areas to sheltering woodlands in extremely cold weather.

SPECIAL HABITAT REQUIREMENTS: Low brushy vegetation.

NESTING: Egg dates: April 15 to August 15, birds in s. New York have at least 2 broods (Bull 1974:417). Clutch size: 4 to 8, typically 5 or 6. Incubation period: 14 days. Nestling period: 13 to 14 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: To 10 feet (0.3 m), typically less than 10 feet (3 m). Nest site: Commonly nests in a cavity in a variety of places both natural and man-made. Less often builds a matted ball of sticks in a low shrub or in grasses that has a side entrance and central cavity.

TERRITORY SIZE: Wrens occupied a wooded ravine-habitat in Kansas for 4 years and defended the following areas: 5.8, 9.2, 3.9, and 7.6 acres (2.3, 3.7, 1.6, and 3.1 ha) (Fitch 1958). Average 0.3 acre (0.1 ha) in a swamp-thicket in Illinois (Brewer 1955).

SAMPLE DENSITIES: Maryland: 11 territorial males per 100 acres (40 ha) in hardwood forest (oaks, tulip-poplar) and scattered pine. 6 territorial males per 100 acres (40 ha) in well-drained flood-plain forest (Stewart and Roberts 1958:235).

FORAGING: Major foods: Insects, occasionally tree wild fruits. Substrates: Trunks of trees, branches, shrubs, leaf surfaces, ground litter. Techniques: Tree shrub, leaf gleaning, creeping.

COMMENTS: Northern limit of this species varies with degree of winter severity (expands in mild winters and recedes with harsh weather). The contents of 291 stomachs collected throughout the year held 94 percent animal and 6 percent vegetable matter (Beal et al. 1913; Bent 1948:209).

KEY REFERENCES: Bent 1948, Nice and Thomas 1948.


House Wren

(*Troglodytes aedon*)

D.U. No. 721.0



Range

 Breeding



RANGE: Breeding: New Brunswick w. to British Columbia, s. to South Carolina, Missouri, and Texas. Winter: Northern Maryland w. to California, s. to s. Mexico. Usually farther n.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (southern New England) to uncommon (Maine).

HABITAT: Breeding: Near human dwellings with sufficient woody vegetation and cavities for nesting, edges of woodlands, farmland, open forests and clearings, suburban gardens, orchards, swampy woodlands. Very adaptable in nesting habits. Avoids deep forest interiors and high elevations. Wintering: Thickets, brushpiles.

SPECIAL HABITAT REQUIREMENTS: Cavity for nesting in wood with minimum d.b.h. of 10 inches (25.4 cm) (Thomas et al. 1979).

REPRODUCTION: Egg dates: May 15 to July 31 (second brood), New York (Bull 1974:413). Clutch size: 5 to 8, typically 6 to 7. Incubation period: About 15 days. Nestling period: 21 to 18 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: To 10 feet (0.3 m), typically less than 5 feet (0.3 m). Nest site: nests in cavity in a variety of sites such as trees, fence posts, tin cans, eaves of buildings, nest boxes. Cavity may be natural, excavated by a woodpecker, or man-made.

TERRITORY SIZE: 178 territories ranged from 0.25 to 2.75 acres (0.1 to 1.1 ha) in forest edge and shrubby pasture habitat in Ohio (Kendeigh 1941b).

SAMPLE DENSITIES: 40 pairs per square mile (15 pairs/km²) (maximum density) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 100 territorial males per 100 acres (40 ha) in farmyard and orchard in Maryland. 50 territorial males per 100 acres (40 ha) in damp deciduous scrub with standing snags in Maryland. 14 territorial males per 100 acres (40 ha) in unsprayed orchard in Maryland (Stewart and Robbins 1958:232).

FORAGING: Major foods: Small insects, beetles, caterpillars, and bugs. Substrates: Low woody vegetation. Techniques: Ground and shrub stem gleaning, hawking.

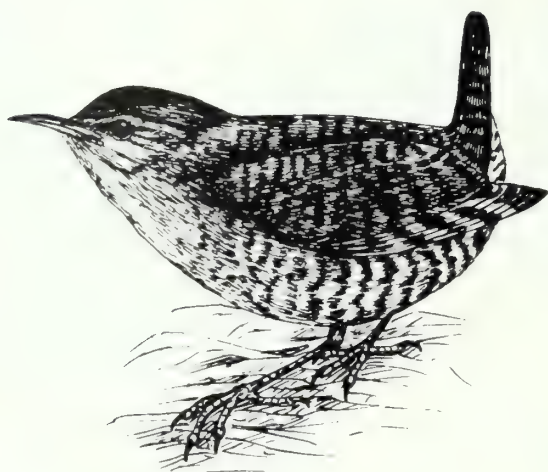
COMMENTS: Males are polygynous.

KEY REFERENCES: Bent 1948, Forbush 1929, Kendeigh 1941b, Odum and Johnston 1951.



Winter Wren

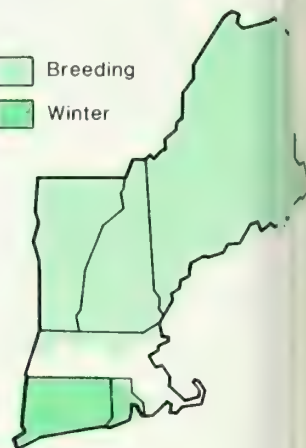
(*Troglodytes troglodytes*)

A.O.U. No. 722.0



Range

-  Breeding
-  Winter



RANGE: Breeding: Newfoundland w. to s. Alaska, s. in the mountains to n. Georgia and n. Colorado. Winter: Southern New England w. to Colorado, s. to the Gulf States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (Massachusetts).

HABITAT: Breeding: Usually in or near dense undergrowth of damp coniferous forests, in thickets near woodland streams, banks of marshy ditches, piles of slash, boreal bogs, usually with a dead log from which to sing. Wintering: Dense undergrowth, especially in moist areas.

SPECIAL HABITAT REQUIREMENTS: Moist coniferous woodlands with low woody vegetation or low-lying cold bogs or swamps. Stevens (1976), however, noted birds in mixed and hardwood forests on north-facing slopes in the mountains of Virginia.

NESTING: Egg dates: May 22 to July 7, New York (Bull 1974:415). Clutch size: 4 to 7, typically 5 or 6. Incubation period: 14 to 16 days. Nestling period: Probably about 2 weeks (Harrison 1975). Broods per year: 2. Age at sexual maturity: 1 year. Nest site: In hollow at base of stump or tree, tangled roots of fallen trees, in cavities in man-made structures, old woodpecker holes.

TERRITORY SIZE: Approximately 1 to 7 acres (0.4 to 2.8 ha) (average 2 to 3 acres (0.8 to 1.2 ha)) in garden-woodland areas (Armstrong 1956:430).

FORAGING: Major food: Insects. Substrate: Ground. Technique: Gleaning.

KEY REFERENCES: Armstrong 1956, Bent 1948.

Sedge Wren

(*istothorus platensis*)

O.U. No. 724.0



Range

 Breeding



RANGE: Breeding: Maine s. to Maryland, w. to Indiana and Kansas. Winter: Coastal areas—s. Maryland, s. to Florida and along the Gulf of Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare. Very local throughout e. parts of range during breeding season. Isolated individuals usually found.

HABITAT: Breeding: Sedge meadows, shallow sedge marshes with scattered shrubs and little or no standing water, coastal brackish marshes of *Spartina patens* with scattered low shrubs and herbs. Wintering: Tidal sedge meadows and marshes.

SPECIAL HABITAT REQUIREMENTS: Sedge meadows.

REPRODUCTION: Egg dates: May 28 to July 30, New York (Bull 191:419). Clutch size: 4 to 8 typically 7. Incubation period: 12 to 14 days. Nestling period: 12 to 14 days. Broods per year: 1 to 3. Age at sexual maturity: 1 year. Nest height: 1 to 3 feet (0.3 to 0.9 m), typically 2 to 3 feet (0.6 to 0.9 m). Nest site: Usually close to the ground and well hidden in meadow grasses. Nests singly or in loose colonies in good habitat. Male builds many unlined dummy nests in territory.

SAMPLE DENSITIES: 35 to 40 singing males were counted on a 10-acre (4-ha) marsh (Harrison 1975:152). 10 territorial males per 100 acres (40 ha) in switchgrass marsh-meadow in Maryland (Stewart and Robbins 1958:238).

FORAGING: Major foods: Insects, spiders. Substrates: Ground, marsh vegetation. Technique: Gleaning.

COMMENTS: The secretive habits of this species have made it difficult to study. Seldom found in same area 2 years in succession in New Hampshire (C. Anderson, personal communication).

KEY REFERENCES: Bent 1948, Walkinshaw 1935.


Marsh Wren

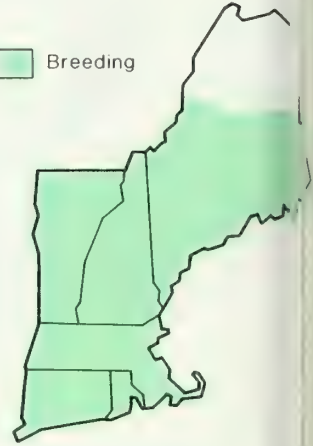
(*Cistothorus palustris*)

A.O.U. No. 725.0



Range

 Breeding



RANGE: Breeding: Southern New Brunswick w. to British Columbia s. to Florida and s. California. Winter: Mid-Atlantic States, w. to Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (Massachusetts).

HABITAT: Breeding: Large fresh or brackish marshes with abundant tall herbaceous vegetation such as cattails, purple loosestrife, sedges or rushes, shores of sluggish rivers, inland ponds. Wintering: Tidal marshes with tall herbaceous vegetation.

SPECIAL HABITAT REQUIREMENTS: Marshes.

NESTING: Egg dates: May 22 to August 7 (second brood), New York (Bull 1974:419). Clutch size: 3 to 8, typically 5. Incubation period: 12 to 16 days. Nestling period: 14 to 16 days. Independence when about 23 days old (Verner 1965). Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 1 to 3 feet (0.3 to 0.9 m). Nest site: Usually in tall marsh plants growing in shallow water, less often in small bushes or trees. Constructs many dummy nests that may be used for roosting (Bull 1974:419).

TERRITORY SIZE: 11 territories averaged 60 m² (71.8 square yards) in tall marsh grasses interspersed with shorter grasses along a river in Georgia. 22 territories averaged 85.3 m² (102 square yards) in *Spartina* spp. along a creek in Georgia (Kale 1965). Territories ranged from 2,600 square feet (241.5 m²) to 38,700 square feet

(3,595 m²) (average 15,000 square feet (1,393.3 m²)) in cattails with scattered stands of bulrush. Territories ranged from 1,800 to 9,600 square feet (167.2 to 884.0 m²) (average 5,000 square feet (464.4 m²)) in narrow strips and patches of bulrush in Washington (Verner 1965). The territories of monogamous males ranged from 13,000 to 15,000 square feet (1,207.6 to 1,393.3 m²) in cattail-sedge association and 30,000 square feet (2,771.6 m²) in grasses in New York (Welter 1935).

SAMPLE DENSITIES: Maryland—104 territorial males per 100 acres (40 ha) in uniform needlerush marsh. 36 territorial males per 100 acres (40 ha) in cattail marsh (Wart and Robbins 1958:236).

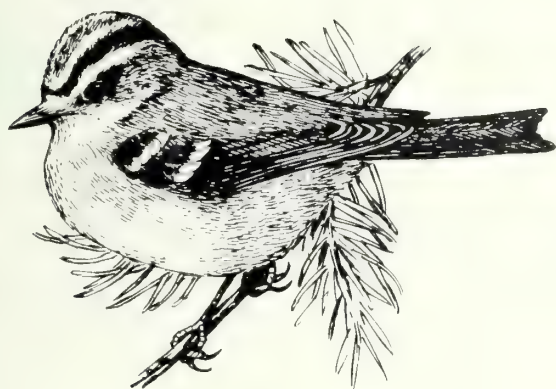
FORAGING: Major foods: Insects, spiders. Substrates: Stems and leaves of marsh vegetation, water. Techniques: Gleaning, hawking.

KEY REFERENCES: Kale 1965, Verner 1965, Welter 1935

Golden-crowned Kinglet

(*Regulus satrapa*)

O.U. No. 748.0



Range

- Breeding
- Winter



RANGE: Breeding: Nova Scotia w. to se. Alaska, s. to Massachusetts, the mountains of North Carolina, New Mexico, and s. California. Winter: Southern New England w. to Ohio and British Columbia, s. to n. Florida and s. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Mainly in dense, northern coniferous forests of spruce but nests in pine, fir, hemlock, and fir-track woods and cedar bogs. Evergreen plantations in central and western New York provide suitable habitat (Bull 1974:443). See comments. Wintering: Moist coniferous, mixed, or deciduous forests (Lepthien and Bock 1971), thickets and low tangles of weedy growth (Pough 1974:126).

REPRODUCTION: Egg dates: May 28 to June 26, New York (Bull 1974:444). Clutch size: 5 to 10, typically 8 or 9. Incubation period: Unknown. Probably 14 to 15 days. Broods per year: 2. Nest height: 6 to 60 feet (1.8 to 18.2 m), typically 30 to 60 feet (9.1 to 18.2 m). Nest site: Usually woven into twigs of a horizontal limb of a conifer.

POPULATION DENSITIES: 1 pair per 2 acres (0.8 ha) in pondack coniferous forest (Andrle 1971). 32 pairs per 100 acres in virgin spruce-hemlock bog forest in Maryland (Stewart and Robbins 1958:255).

FORAGING: Major food: Insects. Substrates: Leaves, branches and twigs, trunks (bark crevices). Techniques: Gleaning, hawking, hover-gleaning.

COMMENTS: Golden-crowned Kinglets have been extending their breeding range in New York by nesting in plantations of spruce with a minimum d.b.h. of 6 inches (15 cm) and dense, closed canopies (Andrle 1971). In New Hampshire this species is limited to boreal habitats (C. Anderson, personal communication).

KEY REFERENCES: Andrle 1971, Bent 1949, Lepthien and Bock 1976.



Ruby-crowned Kinglet

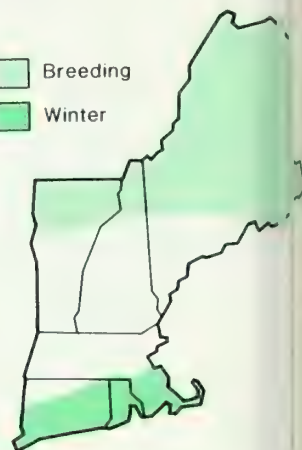
(*Regulus calendula*)

A.O.U. No. 749.0



Range

 Breeding
 Winter



RANGE: Breeding: Quebec w. to Alaska, s. to n. Maine, Adirondacks of New York, Ontario, New Mexico and s. California. Winter: Southern New England w. to British Columbia, s. to s. Florida and Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Northern coniferous forests in pure or mixed stands of spruce, fir, tamarack or pine, forest edges, open stands, bogs. Wintering: Coniferous or deciduous forest understory, open or edge situations, especially in dry oak woodland (Lepthien and Bock 1976).

NESTING: Clutch size: 5 to 11, typically 7 to 9. Incubation period: Believed to be about 12 days. Nestling period: Possibly 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 100 feet (0.6 to 30.5 m), typically 15 to 60 feet (4.6 to 18.2 m). Nest site: Nest is usually well concealed in coniferous shrub or tree at tip of horizontal branch, typically in spruce.

FORAGING: Major foods: Insects (summer), insects supplemented with seeds and fruits (winter). Substrates: Leaf litter; leaves and stalks of herbaceous plants; bark of twigs, branches, and trees; clusters of needles. Techniques: Hawking, gleaning, hover-gleaning. Preferred feeding habitat. In winter, birds forage close to the ground—frequenting thickets and saplings in deciduous as well as coniferous woodlands.

KEY REFERENCES: Bent 1949, Forbush 1929, Lepthien and Bock 1976.

Blue-gray Gnatcatcher

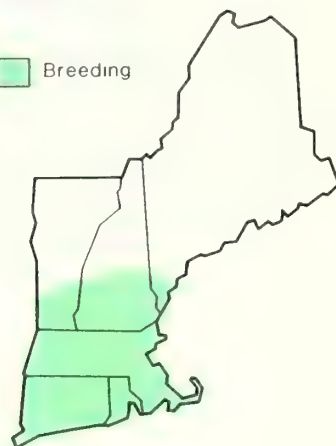
(*Polioptila caerulea*)

D.U. No. 751.0



Range

 Breeding



RANGE: Breeding: Southern New England, w. Pennsylvania, w. to ne. California, s. to s. Mexico. Winter: South Carolina s. through the coastal states to s. California, s. Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare (Maine).

HABITAT: Breeding: Open, moist woodlands interspersed with brushy clearings, often oak, pine, or mixed woods, bottomland forests with closed canopies, wooded swamps, stream-side thickets. Favors tall trees.

SPECIAL HABITAT REQUIREMENTS: An abundant supply of arthropods (Root 1967).

REPRODUCTION: Egg dates: May 14 to June 17, New York (Bull 1974:441). Clutch size: 3 to 5, typically 4 or 5. Incubation period: 13 to 15 days. Nestling period: 10 to 13 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 4 to 70 feet (1.2 to 21.3 m), typically less than 15 feet (4.6 m). Nest site: Usually high in a deciduous or coniferous tree saddled on a horizontal limb or in a fork. Nests in a variety of trees—limb size and shape seem to be more important than tree species (Bent 1949).

TERRITORY SIZE: 9 territories ranged from 2.2 to 7.4 acres (0.9 to 3.0 ha) average 4.6 acres (1.8 ha) in oak woodland and chaparral in California (Root 1970). 1 territory covered 2.2 acres (0.9 ha) along a wooded ravine and rows of trees in Kansas (Fitch 1958).

SAMPLE DENSITIES: Maryland—7 pairs per 100 acres (40 ha) in semi-open floodplain forest. 6 pairs per 100 acres (40 ha) in unsprayed orchard (Stewart and Robbins 1958:254).

FORAGING: Major foods: Apparently feeds exclusively on arthropods, primarily insects. Substrates: Tips of branches, leaf surfaces, bark. Techniques: Hawking, hover-gleaning, twig and leaf gleaning. Preferred feeding habitat: High canopy of forest trees.

COMMENTS: Most breeding birds in New York were seen near lakes or rivers (Bull 1974:441).

KEY REFERENCES: Forbush 1929; Nice 1932, Root 1967, 1970.



Eastern Bluebird

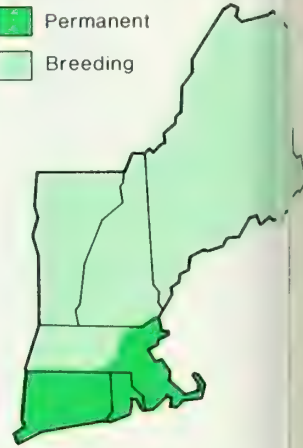
(*Sialia sialis*)

A.O.U. No. 766.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland w. to s. Manitoba, s. to Florida, the Gulf Coast and Central America. Winter: Southern New England w. to s. Michigan, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Open country with scattered trees (savannas), farmlands, open woods, swamps, sparsely inhabited residential areas, roadside fencelines, woodland edges beside fields and meadows, orchards, clearings created by fire, flood, or logging. Wintering: Graber and Graber (1963) found that bluebirds in Illinois favored grasslands, shrub areas, and forest edges in winter.

SPECIAL HABITAT REQUIREMENTS: Low cavities for nesting. Abundant perches for foraging (Pinkowski 1977).

NESTING: Egg dates: April 1 to August 18, New York (Bull 1974:438). Clutch size: 3 to 7, typically 4 or 5. Incubation period: 13 to 15 days. Nestling period: 15 to 18 days. Broods per year: 2 or 3. Age at sexual maturity: 1 year. Nest height: 5 to 20 feet (1.5 to 6.1 m), typically 5 to 12 feet (1.5 to 3.7 m). Nest site: Natural cavities, old woodpecker holes, or nest boxes.

TERRITORY SIZE: 5.4, 8.6, and 7.0 acres (2.2, 3.5, and 2.8 ha) for 3 territories in Kansas (Fitch 1958). 2.5 acres (1.0 ha) (Thomas 1946).

HOME RANGE: Pinkowski (1977) found bluebirds foraging on areas ranging in size from 4.5 to 38.9 ha (11 to 96.1 acres) during nestling periods.

SAMPLE DENSITIES: 30 birds per 100 acres (40 ha) in orchard in Illinois. 34 birds per 100 acres (40 ha) in shrubbery in Illinois. 25 birds per 100 acres (40 ha) in residential habitat in Illinois. 13 birds per 100 acres (40 ha) in second-growth or cutover woods in Illinois (Graber et al. 1971).


FORAGING: Major foods: Insects, especially grasshoppers, crickets, beetles, and caterpillars, make up about 68 percent of diet; fruit represents about 32 percent of diet (Bent 1949:247). Substrates: Leaf and branch surfaces, leaf litter on ground, air. Techniques: Gleaning, flight-gleaning, dropping to ground from perch, hovering. Preferred feeding habitat: Areas with poor soil and sparse ground cover (Pinkowski 1977).

COMMENTS: Suitable nest sites are scarce since many snags have been removed. Starlings, House Sparrows, Tree Swallows, and Wrens compound the problem by competing successfully for cavities. Conner and Anderson (1974) found that clearcuts with standing, cavity-bearing snags provided bluebird nesting habitat for at least 12 years following cutting.

KEY REFERENCES: Bent 1949, Graber et al. 1971, Fitch and Shorne 1962, Lasky 1940, Peakall 1970, Thomas 1946.



Range

 Breeding



GE: Breeding: Newfoundland w. to British Colum-
s. to Long Island and c. New Jersey, and the moun-
t of Georgia, and New Mexico. Winter: South Amer-

UTIVE ABUNDANCE IN NEW ENGLAND: Common.

ATAT: Breeding: Low, moist deciduous woods, bot-
-rand forests, wooded swamps, damp ravines. Prefers
ets of early deciduous second-growth and open
ds with fairly dense high undergrowth of ferns,
rps, and trees. Avoids mountains.

ECIAL HABITAT REQUIREMENTS: Moist woodlands with
d-story of low trees and shrubs.

SING: Egg dates: May 16 to June 25, New York (Bull
7436). Clutch size: 3 to 5, typically 4. Incubation
rid: 10 to 12 days. Nestling period: 16 days. Broods
ear: 1 or 2. Age at sexual maturity: 1 year. Nest
t: To 3 feet (0.9 m), typically on ground. Nest site:
a ground or low in a shrub, tree, or brush pile, often
ellidden on a tussock of ferns or other groundcover.

AMLE DENSITIES: 12 pairs on a 3-acre (1.2 ha) plot of
keide forest with laurel understory in New Hampshire
aring 1925). 8 territorial males per 100 acres (40 ha)
vigin hemlock stand (Stewart and Robbins 1958:251).

OR, SING: Major foods: Mainly insects (about 60 per-
ent and wild fruits and seeds (40 percent). Substrates:
ore floor (leaf litter), leaf and branch surfaces in lower
ancy. Techniques: Ground gleaning, turning leaves
ith ill.

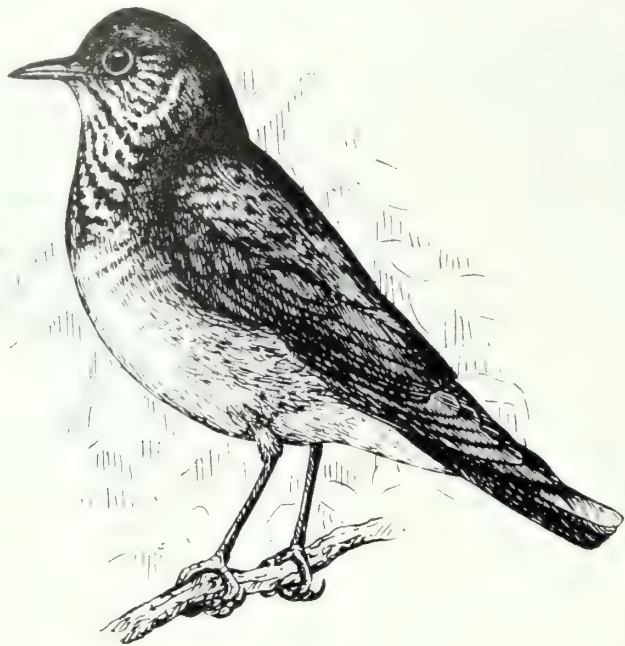
COMMENTS: Bertin (1977) found Veeries in cool wet ar-
eas of both early successional and mature woodlands. In
mature woodlands, Veeries used areas with cool micro-
climates.

KEY REFERENCES: Bent 1949, Bertin 1977, Dilger 1956,
Forbush 1929.

Gray-cheeked Thrush

(*Catharus minimus*)

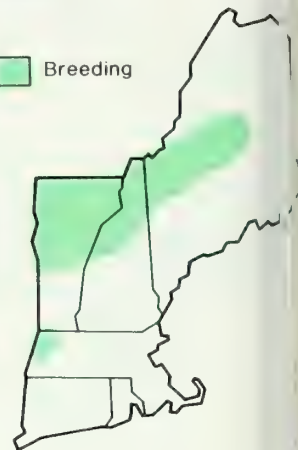
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Range



Breeding



RANGE: Breeding: Northern Newfoundland w. to Alaska s. to the mountains of n. New England and se. New York, and the s. Canadian provinces. Locally in Berkshires and Catskills in highest mountains. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Maine).

HABITAT: Breeding: Moist northern coniferous forests, especially in stunted spruce-fir tangles of mountain tops.

SPECIAL HABITAT REQUIREMENTS: Coniferous forests.

NESTING: Egg dates: June 12 to June 27, New York (Bull 1974:435). Clutch size: 3 to 5, typically 4. Incubation period: 13 to 14 days. Nestling period: About 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: To 20 feet (6.1 m), typically about 6 feet (1.8m). Nest site: Usually in bush or the fork of a low conifer limb, occasionally in a birch, sometimes builds on ground under low-hanging limb.

FORAGING: Major foods: Insects, wild fruits. Substrates: Forest floor which is usually carpeted with sphagnum and other mosses. Techniques: Ground gleaning. Preferred feeding habitat: On ground in forest interior.

COMMENTS: About 75 percent of the diet is animal matter and 25 percent vegetable matter (Beal 1915 in Bent 1949:192).

KEY REFERENCES: Bent 1949, Dilger 1956, Forbush 1927, Wallace 1939.

Lincoln's Thrush

(*Luscinia ustulatus*)

U. No. 758.0



Range



DISTRIBUTION: Breeding: Newfoundland w. to Alaska, s. to n. England, Pennsylvania, Colorado, and s. California. Rarely in mountains of West Virginia and Maryland. Winter: Central and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (see table).

HABITAT: Breeding: Spruce-fir forests especially in low elevation areas near water. Occurs in both young stands and mature forest. Prefers forest interiors to edges. Occasionally breeds in mixed woodlands.

ENVIRONMENTAL HABITAT REQUIREMENTS: Coniferous or mixed deciduous forests.

REPRODUCTION: Egg dates: June 10 to July 11, New York (Bull 1949:433). Clutch size: 3 to 5, typically 4. Incubation period: 10 to 13 days. Nestling period: 10 to 12 days. Reproductive rate per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 20 feet (0.6 to 6.1 m), typically 4 to 8 feet (1.2 to 2.4 m). Nest site: Usually in a crotch close to trunk or horizontal limb of a spruce or fir tree.

FEEDING: Major foods: Insects, wild fruits. Substrates: Forest floor, foliage and branch surfaces, often high in trees. Techniques: Ground gleaning, hawking. Preferred breeding habitat: Forest interior, mainly in trees.

REMARKS: Beal (1915 in Bent 1949:181) found that the March to November diet of 403 birds consisted of 64 percent animal and 36 percent vegetable matter.

KEY REFERENCES: Bent 1949, Forbush 1929, Graber et al. 1971.


Hermit Thrush

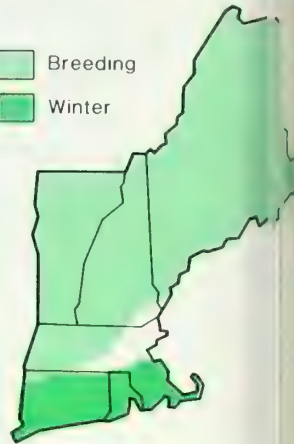
(*Catharus guttatus*)

A.O.U. No. 759.0



Range

 Breeding
 Winter



RANGE: Breeding: Labrador w. to Alaska, s. to s. New York, the mountains of West Virginia and Maryland, c. Minnesota and through the Rockies to New Mexico. Winter: Southern Massachusetts, e. Pennsylvania and s. Ohio s. to Florida and Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (Massachusetts).

HABITAT: Breeding: Lowlands in wooded swamps and damp forests and uplands in dry, brushy clearings in coniferous or mixed forests. Also frequents woodland edges and brushy pastures and cool north-facing slopes. Wintering: Borders of wooded swamps where birds find shelter in thick hummocks. Areas with persistent fruits on shrubs or vines or well-stocked feeding stations (New York) (Bull 1974:432).

SPECIAL HABITAT REQUIREMENTS: Coniferous or mixed woodlands with dense young undergrowth. In winter, birds require abundant native fruits.

NESTING: Egg dates: May 12 to August 24, New York (Bull 1974:431). Clutch size: 3 to 6, typically 3 or 4. Incubation period: 12 days. Nestling period: 12 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: typically on ground. Nest site: Usually on ground on a hummock, or in dense ferns or other cover, or under a low-hanging conifer limb. Occasionally to 4 feet (1.2 m) in a sapling.

SAMPLE DENSITIES: 40 to 93 birds per 100 acres (40 ha) in second-growth or cut-over woods (Fawks 1937, 1938:20 birds per 100 acres (40 ha) in bottomland forest in Illinois (Karr 1968). 6 to 10 birds per 100 acres (40 ha) in upland forest in Illinois (Weise 1951 in Graber et al. 1971).

FORAGING: Major foods: Insects, fruits. Substrate: leaf litter. Technique: Ground gleaning.

COMMENTS: Beal (1915 in Bent 1949:153) found the stomach contents of 551 Hermit Thrushes contained 6 percent animal and 35 percent vegetable matter. Eggs switch to mainly vegetable materials in fall and winter (berries and buds).

KEY REFERENCES: Bent 1949, Dilger 1956, Graber et al. 1971, Morse 1972.

Wood Thrush

(*Turdus mustelina*)

O.U. No. 755.0



Range

 Breeding



RANGE: Breeding: Maine w. to South Dakota, s. to Florida and Texas. Winter: Mexico and Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Mature lowland forests (mainly deciduous or mixed); shady, cool, mature upland forests, especially near a swamp, pond, stream, or lake; sometimes in transitional areas. Requires abundant undergrowth. Absent from higher mountains of New England.

NESTING HABITAT REQUIREMENTS: Deciduous or mixed forests with tall trees and abundant sapling growth. Prefers moist conditions. Apparently requires a tree at least 40 feet (12 m), possibly for song perches (Bertin 1977).

REPRODUCTION: Egg dates: May 17 to July 7, New York (Bull 1974:429). Clutch size: 2 to 5, typically 3 or 4. Incubation period: 13 to 14 days. Nestling period: 12 to 14 days. Fledglings per year: 2. Age at sexual maturity: 1 year. Nest height: 5 to 50 feet, (1.5 to 15.2 m), typically 5 to 12 feet (1.5 to 3.7 m). Nest site: In a fork or saddled on a horizontal limb of a sapling or tree (often elm or maple), or well hidden in dense shrubbery.

TERRITORY SIZE: 0.2 to 2 acres (0.08 to 0.8 ha) (Weaver 1939). 2 to 7 acres (0.8 to 2.8 ha) in forested habitat in central Illinois (Graber et al. 1971). 1.4 acres (0.6 ha) in open and edge in Kansas (Fitch 1958).

POPULATION DENSITIES: Maryland—40 territorial males per 100 acres (40 ha) in virgin hardwood deciduous forest.

16 territorial males per 100 (40 ha) in shrub swamp. 11 territorial males per 100 acres (40 ha) in mature northern hardwood forest. 10 territorial males per 100 acres (40 ha) in mixed oak forest. 4 territorial males per 100 acres (40 ha) in pine-oak forest (Stewart and Robbins 1958:246).

FORAGING: Major foods: Insects, fruits. Substrates: leaf litter on ground, understory vegetation. Techniques: Ground gleaning, scratching, turning leaves over with bill.

COMMENTS: Stomach analyses revealed a diet of 62 percent animal and 38 percent vegetable matter (Bent 1949:113).

KEY REFERENCES: Bent 1949, Bertin 1977, Dilger 1956, Graber et al. 1971, Longcore and Jones 1969.



American Robin

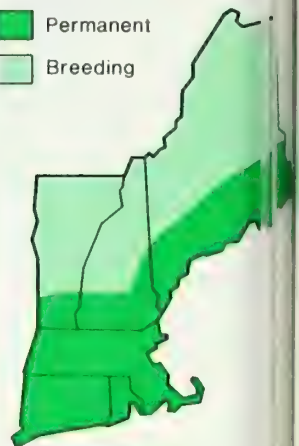
(*Turdus migratorius*)

A.O.U. No. 761.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland w. to Alaska, s. to South Carolina, Texas, Mexico and s. California. Winter: Southern Maine w. to British Columbia, s. to Mexico and Gulf Coast.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Open woodlands and woodland edges and clearings, fields, orchards, shade trees in residential areas. Densities are frequently greater in residential areas than in the wild (Pough 1949:113), though urban populations may not be self-supporting (Howard 1974). Wintering: Frequents sheltered wooded areas more than open exposed pasturelands. Roosts among evergreens in swamps and feeds on persistent wild and cultivated fruits.

NESTING: Egg dates: March 23 to July 19, New York (Bull 1974:428). Clutch size: 2 to 7, typically 3 or 4. Incubation period: 11 to 14 days. Nestling period: 14 to 16 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: to 70 feet. (21.3 m), typically 5 to 15 feet. (1.5 to 4.5 m). Nest site: Robins use a variety of sites for nesting. They prefer to build on a horizontal branch or in a fork of a tree but commonly use shrubs and ledges of buildings. First nest of season is often in a conifer and successive nests in hardwoods. White pine, maple, and apple trees are preferred nest trees (DeGraaf et al. 1975).

TERRITORY SIZE: 0.30 to 0.75 acre (0.1 to 0.03 ha) (Collins and Boyajian 1965:133). 0.11 to 0.60 acres (0.4 to 0.24 ha) (average 0.30 acres (0.1 ha)) in Wisconsin (Young 1951).

SAMPLE DENSITIES: 132 birds per 100 acres (40 ha) in urban residential areas in Illinois (Graber et al. 1971). 14 birds per 100 acres (40 ha) in edge shrubbery in Illinois (Graber et al. 1971). 14 birds per 100 acres (40 ha) in second growth or cut-over woods in Illinois (Bent 1937, 1938).

FORAGING: Major foods: Wild and cultivated earthworms, insects. Substrates: Rich loamy soil, bare ground, shrubs and vines. Techniques: Running, pausing and seizing prey, gleaning. Preferred feeding habitat: Grassy fields, orchards, lawns, gardens.

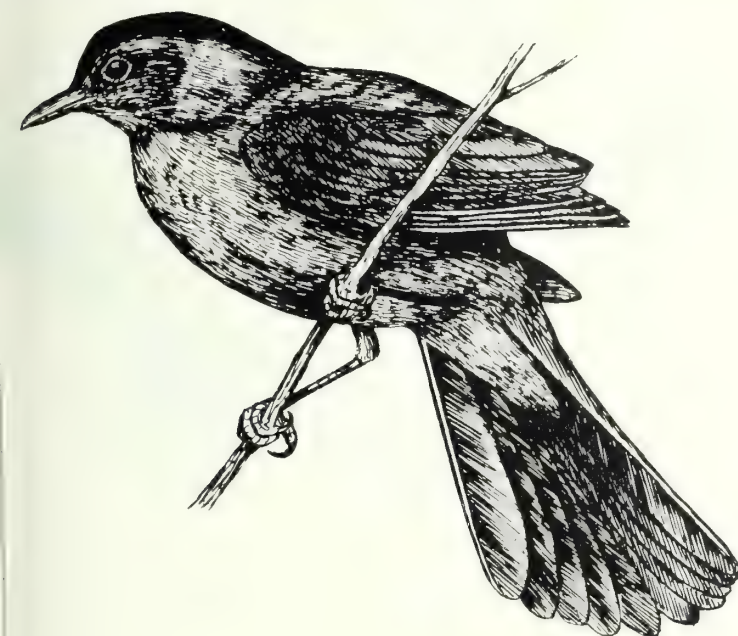
COMMENTS: A study of banding returns by Hickey (1942) indicated that almost three-fourths of the young that survived their first winter returned to nest within 10 km (10 miles) of their birthplaces. About 60 percent of the diet is vegetable matter and 40 percent animal matter (Bent 1949:25).

KEY REFERENCES: Bent 1949, Graber et al. 1971, Howell 1974, Howell 1942, Nickell 1944, Young 1955.

ay Catbird

metella carolinensis)

D.U. No. 704.0



Range

 Breeding



GE: Breeding: Nova Scotia w. to British Columbia, s. Florida and New Mexico. Winter: Coastal sections of Long Island (a few) s. to Mexico.

EATIVE ABUNDANCE IN NEW ENGLAND: Common in breeding season.

ATAT: Breeding: Dense thickets of shrubs, briars, along woodland borders, lowland tangles near streams, ponds and swamps, shrubbery around buildings—especially in hedgerows and gardens, forest clearings with brushy edges. Rare at high elevations. Wintering Milder coastal regions where persistent fruits are available throughout the winter.

ECIAL HABITAT REQUIREMENTS: Low, dense, woody vegetation for nesting, usually with an overtopping deciduous tree layer 10 to 30 feet (3 to 9 m) above (DeGraaf 1971).

ESNG: Egg dates: May 5 to June 13, New York (Bull 1974:422). Clutch size: 3 to 5, typically 4. Incubation period: 12 to 15 days. Nestling period: 9 to 15 days, typically 11 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 3 to 10 feet (0.9 to 3.0 m). Typically 5 feet (1.5 m). Nest site: Builds in dense thickets of briars, shrubs or low trees. Nests are typically well hidden in foliage. Grape vines, hawthorns, and multiflora rose are favored sites.

OM RANGE: 0.16 to 0.36 acres (0.06 to 0.1 ha) (average 0.26 acre (0.1 ha)) in swamp-thicket in Illinois (Brewer 1958).

SAMPLE DENSITIES: 1 nest per 8 acres (3.2 ha) in mixed shrub—small tree habitat within beech-maple-hemlock community in New York (Kendeigh 1946). 40 pairs per square mile (15 pairs/km²) (maximum density) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 80 territorial males per 100 acres (40 ha) in shrub swamp. 35 territorial males per 100 acres (40 ha) in brushy abandoned farmland in Maryland (Stewart and Robbins 1958:241).

FORAGING: Major foods: Small fruits, insects. Substrates: Fruit-bearing shrubs, leaf litter on ground. Technique: Ground gleaning.

COMMENTS: Catbirds use a variety of habitats. Tree and shrub associations are not as important as edge and density of vegetation within the edges (Nickell 1965). Forest edge is preferred to hedgerows in open (Graber et al. 1970).

KEY REFERENCES: Bent 1948, Graber et al. 1970, Nickell 1965.

Northern Mockingbird

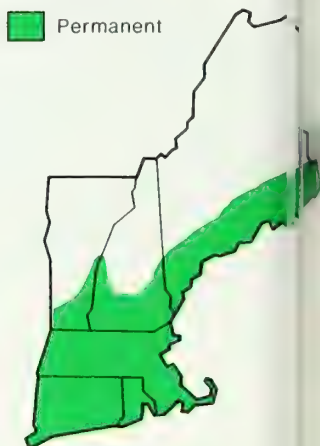
(*Mimus polyglottos*)

A.O.U. No. 703.0



Range

Permanent



RANGE: Breeding: Southern Maine w. through Ohio to c. California, s. to the Gulf Coast and s. Mexico. Spreading n. Winter: Southern New England, s. and w.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Woodland edges, pastures with scattered fruit-bearing shrubs, small trees or groves of large trees, often in cities and habitat. Wintering: Similar to breeding habitat; among thickets that bear persistent fruits, especially multiflora rose.

SPECIAL HABITAT REQUIREMENTS: Low, dense woody vegetation, elevated perches, a variety of edible fruits.

NESTING: Egg dates: April 27 to July 21, New York (Bull 1974:425). Clutch size: 3 to 6, typically 4 or 5. Incubation period 14 days. Nestling period: 10 days (10 to 12 days in Tennessee (Laskey 1962)). Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 1.5 to 10 feet (0.5 to 3.0 m). Typically 3 to 10 feet (0.9 to 3.0 m). Nest site: Usually in a thicket of shrubs or vines or in a dense tree (often an evergreen). Prefers sites near houses, especially porch vines, garden, lawn and foundation plantings. Prefers to nest in multiflora rose (DeGraaf et al. 1975).

TERRITORY SIZE: Territories of 5 pairs of mockingbirds ranged from 26,650 to 60,000 square feet (2,475.5 to 5,573.3 m²) (Michener and Michener 1935). Winter: four females defended areas that ranged from 3,750 to 20,000 square feet (348.3 to 1857.8 m²) (Michener and Michener 1935).

HOME RANGE: 2 pairs in Michigan occupied the ranges of 45 acres (18.2 ha) compared with an average of 2.5 acres (1.0 ha) in Tennessee (Adkisson 1966:104).

SAMPLE DENSITIES: Maryland: 15 territorial males per 100 acres (40 ha) in suburban-residential habitat. 2 territorial males per 100 acres (40 ha) in mixed agricultural habitats (Stewart and Robbins 1958:239).

FORAGING: Major foods: Wild or cultivated fruits, seeds, insects. Substrates: Ground litter and grasses, shrubs, trees. Techniques: Ground, shrub gleaning.

COMMENTS: Studies by Beal and others (1916) revealed that in May the bulk of the diet consists of animal matter (85 percent) and in December and January mockingbirds eat mainly vegetable matter (87 percent) (Bent 1948:305).

KEY REFERENCES: Bent 1948, Laskey 1962, Michener and Michener 1935.

Crown Thrasher

(*Geothlypis trichas*)

O.U. No. 705.0



Range

 Breeding



RANGE: Breeding: Maine w. to s. Alberta s. to Florida on the Gulf Coast. Winter: Long Island and coastal sections of New Jersey s. to Maryland, coastal and inland Virginia to Missouri s. to Florida and Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Nine).

HABITAT: Breeding: Bushes, low trees, tangle of vines in open pastures or woodland edges and clearings in early stages of second growth. Hedgerows along roadsides and fields are preferred (Graber et al. 1970). Absent from higher mountains of New England. Wintering: Coastal areas where climate is mild and sparse snow cover allows birds to find fruits.

SPECIAL HABITAT REQUIREMENTS: Low, dense woody vegetation for nesting and cover (Graber et al. 1970).

REPRODUCTION: Egg dates: May 6 to June 26, New York (Bull 1949:423). Clutch size: 3 to 6, typically 4. Incubation period: 12 to 13 days. Nestling period: 12 to 13 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: To 14 feet (4.3 m), typically 2 to 7 feet (0.6 to 2.1 m). Nest site: On ground or low in dense cover of a shrub or vine. Less often in a low tree.

TERRITORY SIZE: Average 1.6 acres (0.6 ha) in forest edge in Illinois (Graber et al. 1970).

SAMPLE DENSITIES: 3 pairs per 100 acres (40 ha) in forest edge (Holmes 1950 in Graber et al. 1970). 189 birds per 100 acres (40 ha) in hedgerows and 76 birds per 100

acres (40 ha) in edge shrubbery (Graber and Graber 1963). 86 birds per 100 acres (40 ha) in second-growth or cut-over woods (Fawks 1937).

FORAGING: Major foods: Insects (about 66 percent; berries, mast (acorns), and grain (about 33 percent) (Pough 1949: 110). Substrates: Leaf litter, soft earth, low vegetation. Techniques: Ground and shrub gleaning.

KEY REFERENCES: Bent 1948, Erwin 1935, Graber et al 1970.

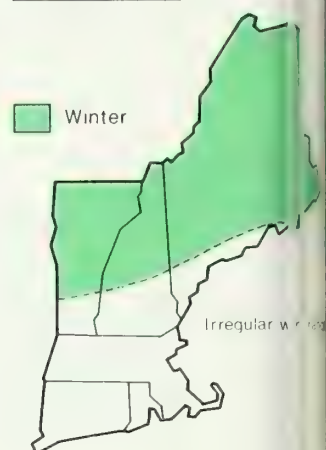
Bohemian Waxwing

(*Bombycilla garrulus*)

A.O.U. No. 618.0



Range



RANGE: Breeding: Boreal and temperate areas of North America. Winter: Irregularly to s. California, the Prairie States, and the Mid-Atlantic states.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: Unreported.

FORAGING: Major foods: Berries in winter. Substrate: Fruit-bearing trees and shrubs. Techniques: Gleaning.

KEY REFERENCE: Forbush 1929.

Cedar Waxwing

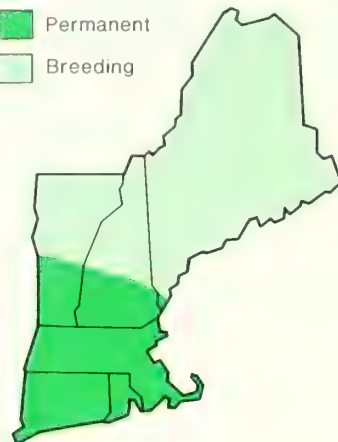
(*Ambycilla cedrorum*)

O.U. No. 619.0



Range

- Permanent
- Breeding



RANGE: Breeding: Nova Scotia, w. to British Columbia, n. to Georgia, New Mexico and n. California. Winter: Central New England, w. to Oregon, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common in the north, uncommon in the south.

HABITAT: Breeding: Open deciduous and coniferous woodlands (avoids dense forests), orchards, shade trees. Winter: Open country, commonly in agricultural areas and near water. Wintering: same.

REPRODUCTION: Egg dates: June 5 to September, New York (Bull 1949:450). Clutch size: 2 to 6, typically 4 or 5. Incubation period: 12 to 16 days. Nestling period: 12 to 18 days. Breeds per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 4 to 50 feet (1.2 to 15.2 m). Typically 6 to 20 feet (1.8 to 6.1 m). Nest site: Prefers dense coniferous thickets (often cedar) but nests in a variety of deciduous trees and shrubs. Nest is placed on a horizontal limb, often in a crotch next to main trunk.

TERRITORY SIZE: 3 territories on an island in Lake Erie had the following areas: 0.06 acre, 0.5 acre and 0.23 acre (0.02, 0.2, and 0.09 ha) (Putnam 1949).

POPULATION DENSITIES: 20 nests were found in a 2.3-acre (0.9-ha) white pine plantation in Michigan (Rothstein 1971). 1 nest was located within a radius of 25 feet (7.6 m) in Ontario (Harrison 1975:166). 16 pairs per 100 acres (40 pairs per 100 ha) in an open hemlock-spruce bog in Maryland (Stewart and Robbins 1958).

FORAGING: Major foods: Fresh and dried fruits and flowers (80 percent), insects (20 percent). Substrates: Leaf surfaces, fruit-bearing branches. Techniques: Gleaning, hawking.

COMMENTS: Waxwings tend to nest late in summer when there is an abundant supply of wild fruits. Birds nest singly or in loose colonies. A second nest is often begun and eggs laid before the young in the first nest have fledged. During most of the year they roam the countryside in small to large flocks.

KEY REFERENCES: Bent 1950, Lea 1942, Putnam 1949.

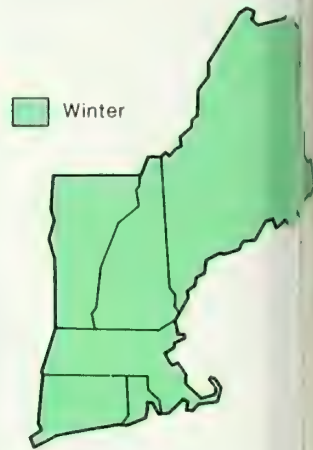
Northern Shrike

(*Lanius excubitor*)

A.O.U. No. 621.0



Range



RANGE: Breeding: Northern North America, s. to s. Canada. Winter: Same as above but occasionally wanders s. to Virginia, New Mexico and n. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare (winter).

HABITAT: Wintering: Semi-open country with short grasses and scattered trees or shrubs for perches. Fences and utility wires also used.

SPECIAL HABITAT REQUIREMENTS: Elevated perches, short vegetation.

FORAGING: Major foods: Rodents, especially mice, small birds. Substrates: Meadow grasses, air. Techniques: Hawking, diving and pouncing from a perch, hovering. Preferred feeding habitat: Open fields with scattered perches.

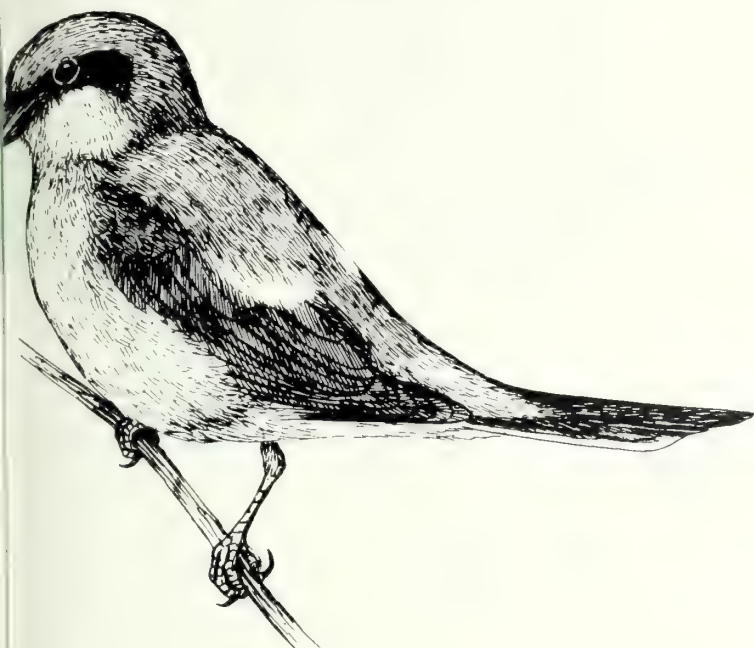
COMMENTS: Northern shrikes are seen in the Northeast in winter when northern rodent populations are low—about every 4 years (Pough 1949:133).

KEY REFERENCES: Bent 1950, Cade 1967, Miller 1931.

Loggerhead Shrike

(*Lanius ludovicianus*)

O.U. No. 622.0



Range

 Breeding



RANGE: Breeding: New Brunswick, w. to British Columbia, s. to s. Florida and s. Mexico. Winter: s. New Jersey, n. California, s. to s. Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and local in Northeast.

HABITAT: Breeding: Open country with scattered trees, roads, roadside hedges. Is attracted to areas with many trees such as hawthorn and honey locust. Favors elevations.

ADDITIONAL HABITAT REQUIREMENTS: Open areas with short grasses, elevated perches from which to spot prey.

REPRODUCTION: Egg dates: April 18 to June 28, New York (Bull 1974:453). Clutch size: 4 to 7, typically 4 or 5. Incubation period: 16 days. Nestling period: 16 to 20 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 5 to 13 feet (1.5 to 9.1 m). Typically 8 to 15 feet (2.4 to 4.6 m). Nest site: Builds in the dense foliage of a tree or shrub. Prefers to nest in thorny plants but is known to nest in oaks, pines, orchard trees, and grapevine.

TERRITORY SIZE: 18.7 acres (7.6 ha) (Miller 1931).

POPULATION DENSITIES: 1.9 nests per mile (1.6 km) of hedge in New Jersey (Graber et al. 1973).

DIET: Major foods: Insects, small reptiles, amphibians, birds, and mammals. Substrate: Meadow grasses. Feeding techniques: Hovering or perching and diving, hawk-like.

COMMENTS: Beal (1912 in Bent 1950:137) found that the contents of 88 stomachs held mainly animal matter (97.5 percent) and a trace of vegetable matter (2.5 percent). Shrikes habitually impale their prey in thorn trees or on barbed wire fences or hang the prey in the fork of a branch. Formerly nested in New Hampshire (C. Anderson, personal community).

KEY REFERENCES: Bent 1950, Graber et al. 1973, Miller 1931.

European Starling

(*Sturnus vulgaris*)

A.O.U. No. 493.0



Range

 Permanent



RANGE: Breeding: Southern half of Canada s. throughout most of United States except in extreme sw. portions, though now invading n. Sonoran Desert. Winter: Throughout United States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Farms, cities, orchards, gardens, parks. Prefers rural areas with pastures, cultivated fields and hayfields. Wintering: Roost in dense vegetation or on buildings in villages and cities. Probably absent from high mountains.

SPECIAL HABITAT REQUIREMENTS: Cavities for nesting. Minimum d.b.h. of trees suitable for nesting is 10 inches (25.4 cm) (Thomas et al. 1979).

NESTING: Egg dates: April 10 to June 15, New York (Bull 1974:541). Clutch size: 2 to 7, typically 4 to 6. Incubation period: 11 to 13 days. Nestling period: 18 to 22 days. Broods per year: 1 or 2. May be single-brooded north of 48° latitude (Kessel 1953). Age at sexual maturity: 1 year. Nest height: 2 to 60 feet (0.6 to 18.3 m). Typically 10 to 25 feet (3.0 to 7.6 m). Nest site: A cavity almost anywhere, including crevices created by highway construction in exposed rock ledges. Often in natural or existing excavated cavities in trees, barns and other buildings, drain pipes, cupolas.

TERRITORY SIZE: Birds defended a 10- to 20-inch (25.4 to 50.8 cm) radius around nest holes (Kessel 1957).

SAMPLE DENSITIES: 78 breeding females per square mile (20 breeding females/km²) (some in nest boxes) on a farm in Scotland (Dunnet 1955).

FORAGING: Major food: Insects, seeds, fruits, cultivated grains. Substrates: Soil surface, sub-surface to depth not exceeding length of bill. Techniques: Ground gleaning, probing. Preferred feeding habitat: Lawns, meadows, grazed fields; starlings prefer to forage in low vegetation; feeds up to three-fourths of a mile from nest (Kessel 1957).

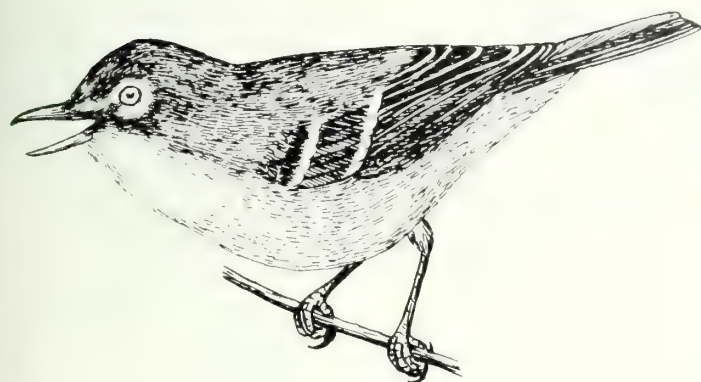
COMMENTS: Introduced from Europe, starlings are highly adaptable and compete successfully with other birds for nest cavities. Stomach analyses of 2,301 birds taken throughout the United States in all seasons revealed a diet of 57 percent animal and 43 percent vegetable matter (Kalmbach and Gabrielson 1921 in Bull 1950:194).

KEY REFERENCES: Dunnett 1955, Kessel 1957, Williams and Gray 1975.


White-eyed Vireo

(*Vireo griseus*)

U. No. 631.0



Range

 Breeding



RE: Breeding: Southern New England and se. New York w. to Wisconsin and Nebraska, s. to Mexico and Gulf Coast. Winter: South Carolina w. to s. Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common (Rhode Island) to rare (Maine).

HABITAT: Breeding: Dense shrubby lowlands, briar patches, deciduous forest undergrowth and forest edges, hedgerows, old fields, low swampy areas. Less common on drier hillsides and along rural roads.

LOCAL HABITAT REQUIREMENTS: Low shrubby vegetation that provides foraging and nesting substrates.

REPRODUCTION: Egg dates: May 17 to July 17, New York (Bull 1944). Clutch size: 3 to 5, typically 4. Incubation period: 14 to 15 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 8 feet (0.3 to 2.4 m). Usually 2 to 6 feet (0.6 to 1.8 m). Nest site: Suspended in the fork of a low branch, usually well hidden by overhanging vegetation. Most often placed in a small shrub or twig.

TERRITORY SIZE: Approximately 2.5 to 3.5 acres (1.0 to 1.4 ha) per male (Stewart and Robbins 1958). Territories may be as small as 0.33 (0.13 ha) acre per male (Brewer 1955). 6.5 and 5.4 acres (2.6 to 2.2 ha) in stream and woodland edge thickets in Kansas (Fitch 1958).

POPULATION DENSITIES: Maryland—40 territorial males per 100 acres (40 ha) in shrub swamp. 32 territorial males per

100 acres (40 ha) in second-growth river swamp. 28 territorial males per 100 acres (40 ha) in brushy abandoned farmland (Stewart and Robbins 1958:263).

FORAGING: Major foods: Insects, wild fruits. Substrates: Branches and twigs, leaf surfaces. Techniques: Gleaning, hover-gleaning. Preferred feeding habitat: Feeds mainly in the inner canopy of trees and shrubs.

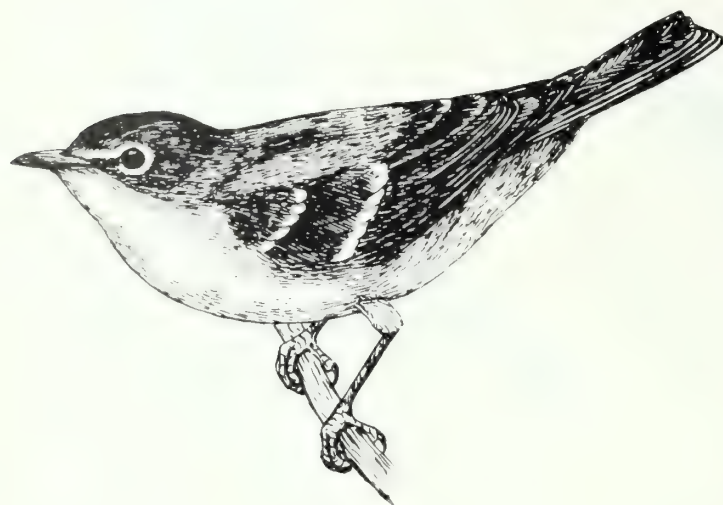
COMMENTS: The White-eyed Vireo prefers close-growing stands of trees 8 to 25 feet (2.4 to 7.6 m) tall (either saplings or mature low trees such as *Crataegus* spp.) (Nolan 1960). The bird is a common victim of cowbird parasitism.

KEY REFERENCES: Bent 1950, Nolan 1960, Saunders 1915.


Solitary Vireo

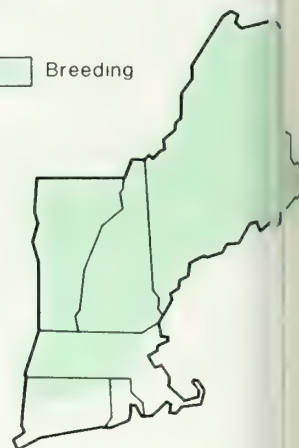
(*Vireo solitarius*)

A.O.U. No. 629.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. to British Columbia, s. to Connecticut (uplands), Georgia (mountains), c. Minnesota and Mexico (mountains). Winter: South Carolina to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (s. Connecticut).

HABITAT: Breeding: Coniferous or mixed woodlands especially those with openings in canopy and a dense understory. Shows preference for pine, hemlock, or spruce. Prefers mountain elevations but occurs locally in highlands.

NESTING: Egg dates: May 14 to July 22, New York (Bull 1974:459). Clutch size: 3 to 5, typically 4. Incubation period: 13 to 15 days. Nestling period: 15 to 17 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 3.5 to 20 feet (1.1 to 6.1 m). Typically less than 10 feet (3.0 m). Nest site: Suspended from a forked horizontal branch, usually a conifer.

SAMPLE DENSITIES: Average 29 birds per 100 acres (40 ha) in ponderosa pine forest in Colorado (Cruz 1975). 27 territorial males per 100 acres (40 ha) in virgin hemlock forest in Maryland. 17 territorial males per 100 acres (40 ha) in mature northern hardwood forest in Maryland (Stewart and Robbins 1958:265).

FORAGING: Major foods: Insects, especially moths and caterpillars, small amounts of fruits. Substrates: Bark of branches, often at bases of horizontal branches and dead

stubs. Techniques: Gleaning, hover-gleaning, picking. Preferred feeding habitat: Lower and middle canopy.

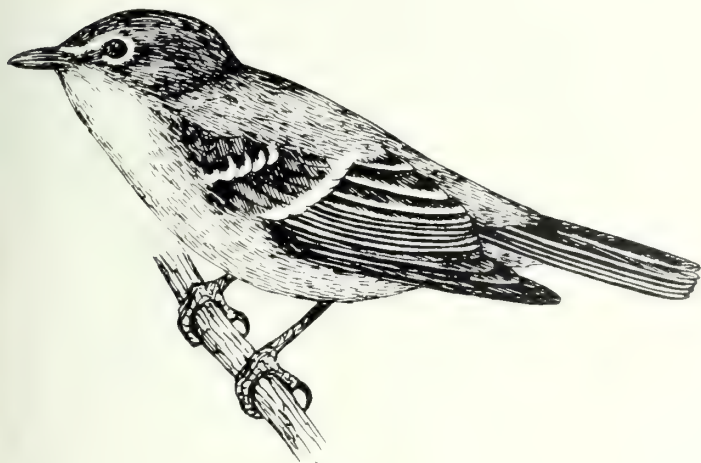
COMMENTS: Chapin (1925 in Bent 1950:296) found the bulk of diet (306 stomachs) to be animal matter (96 percent) supplemented by small amounts of vegetable matter (4 percent).

KEY REFERENCES: Bent 1950, Cruz 1975, James 1976


Yellow-throated Vireo

(*Vireo flavifrons*)

O.U. No. 628.0



Range

 Breeding



DISTRIBUTION: Breeding: Maine, w. to Saskatchewan, s. to Florida and Texas. Winter: Southern Mexico to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare (Maine).

HABITAT: Breeding: Tall deciduous trees in woodlands and partially opened canopy, seldom in dense forests, rarely in conifers. Frequents roadsides, borders of fields, orchards and woodland borders, swampy woods.

ESSENTIAL HABITAT REQUIREMENTS: Tall deciduous trees.

REPRODUCTION: Egg dates: May 24 to June 18, New York (Bull 1974:457). Clutch size: 3 to 5, typically 4. Incubation period: 14 days. Nestling period: About 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 3 to 6 feet (0.9 to 1.8 m). Typically over 20 feet (6.1 m). Nest site: Suspended between a fork formed by slender branches of a horizontal limb, typically over 20 feet (6.1 m) above ground.

TERRITORY SIZE: About 10 acres (4.0 ha) (Robbins, unpublished data cited in Williamson 1971).

POPULATION DENSITIES: Maryland: 19 territorial males per 100 acres (40 ha) in virgin hardwood deciduous forest. 8 territorial males per 100 acres (40 ha) in second growth forest. 7 territorial males per 100 acres (40 ha) in cypress swamp. 3 territorial males per 100 acres (40 ha) in mixed oak forest. 3 territorial males per 100 acres (40 ha) in well-drained floodplain forest (Stewart and Robbins 1958:264).

FORAGING: Major foods: Insects, especially adult and larval moths. Substrates: Twig and branch surfaces, less often on leaf surfaces. Techniques: Gleaning—typically feeds slowly and deliberately, occasionally hovering or hawking. Preferred feeding habitat: Top of canopy (upper half), periphery and central portions (Williamson 1971).

COMMENTS: Chapin (1925 in Williamson 1971) found that the diet over a 1-year period consisted of 98 percent animal and 2 percent vegetable matter.

KEY REFERENCES: Bent 1950, James 1976, Williamson 1971.


Warbling Vireo

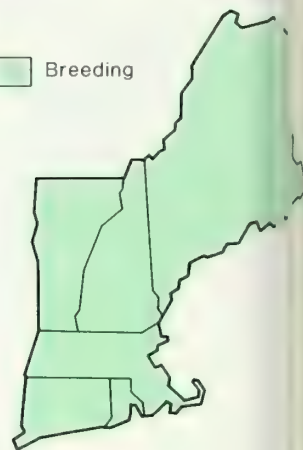
(*Vireo gilvus*)

A.O.U. No. 627.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. to British Columbia, s. to North Carolina, n. Mexico and s. California. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon and widespread.

HABITAT: Breeding: Open mixed or deciduous woodlands, roadside and village shade trees, riverbottoms with mature trees, orchards. Avoids high elevations.

SPECIAL HABITAT REQUIREMENTS: Deciduous trees.

NESTING: Egg dates: May 16 to June 16, New York (Bull 1974:462). Clutch size: 3 to 5, typically 4. Incubation period: about 12 days. Nestling period: About 16 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 20 to 90 feet (6.1 to 27.4 m). Nest site: In horizontal fork of a slender branch usually well away from trunk. Typically protected by a canopy of leaves. Usually nests higher than other Vireos.

SAMPLE DENSITIES: 10 territorial males per 100 acres (40 ha) in field with shrubs and stream-bordered trees in Maryland (Stewart and Robbins 1958:269).

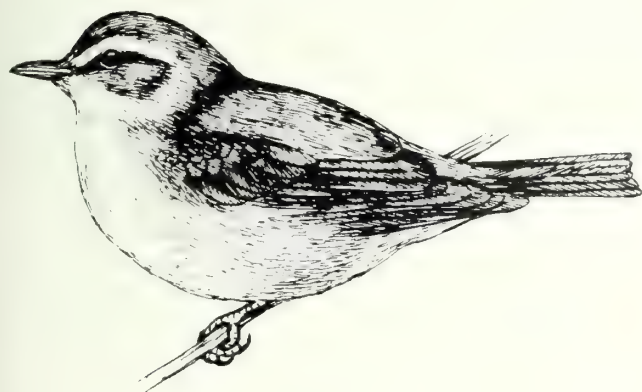
FORAGING: Major foods: Insects, especially caterpillars. Substrates: Leaf surfaces. Techniques: Flight-gleaning, gleaning. Preferred feeding habitat: Middle and upper canopy of tall deciduous trees, largely on branch tips.

KEY REFERENCES: Bent 1950, James 1976.

Philadelphia Vireo

(*Vireo philadelphicus*)

D.U. No. 626.0



Range

 Breeding



RANGE: Breeding: New Brunswick, w. to Alberta, s. to n. e. England (rarely), Michigan and North Dakota. Winter Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (vine).

HABITAT: Breeding: Deciduous, coniferous or mixed forests, woodland edges, clearings, and burned-over areas with young deciduous second growth, neglected farm-lands grown up to small trees and tall shrubs interspersed with clearings, willow and alder thickets along streams. Rarely in villages.

SPECIAL HABITAT REQUIREMENTS: Deciduous trees for nesting.

REPRODUCTION: Egg dates: June 15 to July 15, Maine (Bent 1909:362). Clutch size: 3 to 5, typically 4. Incubation period: 14 days. Nestling period: 13 days. Brood period: 1. Age at sexual maturity: 1 year. Nest height: 10 to 100 feet (3.0 to 12.2 m). Nest site: Nest is hung in the fork of a slender horizontal twig of a deciduous tree or shrub.

FEEDING: Major foods: Insects, especially caterpillars; some wild fruits in autumn (less than 10 percent). Substrates: Leaf surfaces, branches. Techniques: Flight-feeding, gleaning, hawking. Preferred feeding habitat: forest tops, dense shrubbery.

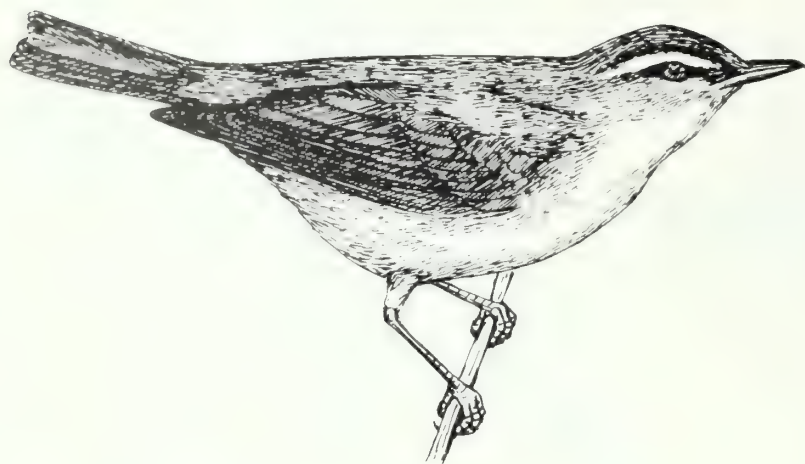
COMMENTS: Animal matter represented 73 percent of the diet during the breeding season (McAtee 1926 in Bent 1950:356).

KEY REFERENCES: Bent 1950. Lewis 1921.


Red-eyed Vireo

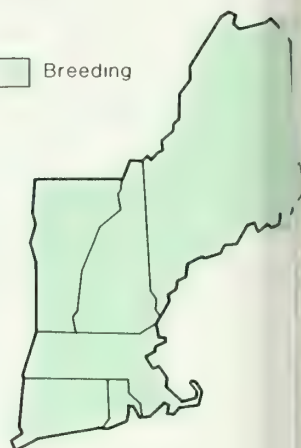
(*Vireo olivaceus*)

A.O.U. No. 624.0



Range

 Breeding



RANGE: Breeding: Quebec, w. to British Columbia, s. to Florida and s. South America. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Open deciduous and second-growth woodlands (less often in mixed woods) with thick undergrowth of saplings. Frequents residential areas with abundant shade trees that provide a continuous canopy. Ubiquitous and common in deciduous woodland, yet shows preference for mesic stands in the deciduous forest (Bond 1957).

SPECIAL HABITAT REQUIREMENTS: Deciduous trees. A continuous canopy rather than presence of an understory may be the chief habitat requirement (Lawrence 1953).

NESTING: Egg dates: May 13 to July 7, New York (Bull 1974:459). Clutch size: 2 to 5, typically 4. Incubation period: 12 to 14 days. Nestling period: 10 to 12 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 2 to 60 feet (0.6 to 18.3 m). Typically 5 to 10 feet (1.5 to 3.0 m) DeGraaf and others (1975) found Red-eyed Vireos ($n = 20$) nesting at an average height of 17 feet (5.2 m) in a nest site study in Massachusetts. Nest site: Suspended in the fork of a horizontal limb often in a sapling, usually in a peripheral area of canopy.

TERRITORY SIZE: 45 territories in Michigan averaged 1.7 acres (0.7 ha) per pair (Harrison 1975:172). 5 territories in mixed woods in Ontario ranged from 0.7 to 2.4 acres (0.3 to 1.2 ha) (average 1.4 acres (0.6 ha)) (Lawrence 1953).

SAMPLE DENSITIES: Maryland — 60 territorial males per 100 acres (40 ha) in mature northern hardwood forest. 100 territorial males per 100 acres (40 ha) in virgin hardwood deciduous forest. 52 territorial males per 100 acres (40 ha) in dense second-growth forest. 34 territorial males per 100 acres (40 ha) in pine-oak forest. 10 territorial males per 100 acres (40 ha) in open slash and burn (Stewart and Robbins 1958:266).

FORAGING: Major foods: Insects (more than 85 percent of diet), mainly caterpillars, moths, beetles, bugs, and flies. Substrates: Leaf surfaces, especially undersides. Techniques: Gleaning, flight-gleaning, hawking (uncommon), glides rather than hops from branch to branch. Preferred feeding habitat: Uppermost branches of trees. Most feeding occurs in periphery of middle and upper canopy; little feeding takes place in core.


KEY REFERENCES: Bent 1950, James 1976, Lawrence 1953, Southern 1958, Williamson 1971.

Blue-winged Warbler

(*Parus ceruleus*)



Range

 Breeding



RANGE: Breeding: Southern Wisconsin, s. Michigan, n. Ohio, w. Pennsylvania, w. and se. New York, s. New England, s. to s. Illinois, c. Tennessee, Kentucky, n. Alabama, n. Georgia, North Carolina, n. Virginia, ne. Maryland, Delaware. Winter: Winters from s. Mexico to Guatemala, and Nicaragua and casually to Panama and Colombia; also w. Cuba.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to locally common.

HABITAT: Breeding: Edges of woods, bushy overgrown fields or borders of wooded swamps. Prefers old fields with saplings greater than 10 feet tall (Robbins et al. 1966:254). Often near streams.

SPECIAL HABITAT REQUIREMENTS: Old fields with scattered shrubs and small trees.

REPRODUCTION: Egg dates: May 18 to June 17, New York (Bull 1971:468). Clutch size: 4 to 7, typically 5. Incubation period: 10 to 12 days. Nestling period: 8 to 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On the ground on a foundation of dry leaves, surrounded by bushes or tangles of vines and grasses.

TERRITORY SIZE: Less than 1 acre (0.4 ha) to almost 2 acres (0.8 ha) per pair (New York) (Ficken and Ficken 1968). Isle Lake, Michigan (2.0 ha (5 acres) per pair) — habitat: an extensive tamarack swamp surrounded by drier, drier oak-hickory woods. Island Lake, Michigan (1.1 ha (4.6 acres) per pair) — habitat: a low swamp of

tamarack, poison sumac, red osier and gray dogwoods and poplars (Murray and Gill 1976).

FORAGING: Major foods: Caterpillars, beetles, ants, spiders. Substrates: Branches at tops of trees. Techniques: Twig and leaf gleaning.

KEY REFERENCES: Bent 1953, Short, 1962.


Golden-winged Warbler

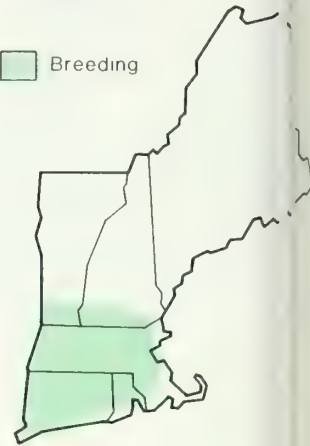
(*Vermivora chrysoptera*)

A.O.U. No. 642.0



Range

 Breeding



RANGE: Breeding: Wisconsin, s. Michigan, c. New York, s. Connecticut, c. Massachusetts, s. Vermont, s. to n. Illinois, n. Indiana, s. Ohio, w. Pennsylvania, n. New Jersey; in mountains to n. Georgia. Winter: Winters from Guatemala s. to n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare (Vermont).

HABITAT: Breeding: Damp fields heavily vegetated with thick grass, clumps of bushes and briars, deciduous damp woods, especially gray birch stands; sometimes found on higher ground. Avoids mountains.

SPECIAL HABITAT REQUIREMENTS: Brushy open areas, especially clearings in deciduous woodlands with saplings, forbs, grasses.

NESTING: Egg dates: May 18 to June 16, New York (Bull 1974:469). Clutch size: 4 to 6, typically 5. Incubation period: 10 days. Nestling period: 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On the ground generally supported by a base of dead leaves and weed stalks.

TERRITORY SIZE: Less than 1 acre (0.4 ha) to almost 2 acres (0.8 ha) per pair (New York) (Ficken and Ficken 1968). Territories usually consisted of overgrown fields with many shrubs and small trees (under 20 feet) (6.0 m), bordered by taller deciduous trees. Burke Lake, Michigan (2.7 ha (6.7 acres) per pair) — habitat: an extensive tamarack swamp surrounded by higher, drier oak-hickory woods. Island Lake, Michigan (1.9 ha (4.7 acres) per pair) — habitat: a low swamp of tamarack, poison sumac,

red osier and gray dogwood and poplars (Murray and Gill 1976).

SAMPLE DENSITY: 17 territorial males per 100 acres (40 ha) in dense second-growth forest in Maryland (Stewart and Robbins 1958:276).

FORAGING: Major foods: Small bugs and larvae, caterpillars, worms, spiders. Substrates: Terminal twigs of high branches in tall trees. Techniques: Twig hopping and gleaning.

COMMENTS: Chickadee-like in feeding habits. Occurs in similar habitat as Blue-winged Warbler with which it interbreeds. Golden-winged Warblers may breed at higher elevations and slightly farther north than Blue-winged Warblers (Bull 1974:469).

KEY REFERENCES: Griscom and Sprunt 1957, Short 1992.


Tennessee Warbler

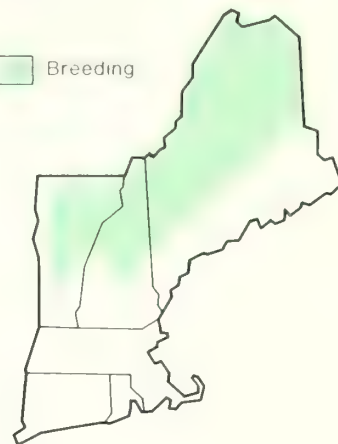
(*ermivora peregrina*)

O.U. No. 647.0



Range

 Breeding



GE: Breeding: Northern border of United States s. to Wisconsin, n. Michigan, ne. New York, s. Vermont, c. Hampshire, s. Maine. Winter: From Guatemala e. Colombia and n. Venezuela.

LTIVE ABUNDANCE IN NEW ENGLAND: Common (Bull 1974:475)).

AT: Breeding: Associated with openings in north-deciduous or mixed woodlands with grasses, dense rps, and scattered clumps of young deciduous trees (ough 1949:156). Often in boggy areas, occasionally on y line lands.

ECIAL HABITAT REQUIREMENTS: Brushy, semi-open ury.

ESNG: Egg dates: June 10 to July 10. Peak: June 17 to n26, New Brunswick (Bent 1953:89). Clutch size: 4 to typically 6. Incubation period: 11 to 12 days. Broods r ear: 1. Age at sexual maturity: 1 year. Nest site: On oig ground, in moss or grass, often at base of shrub. Is udy well concealed.

ORING: Major foods: Almost entirely insectivorous, ke weevils, flies, plant-lice, grasshoppers, caterpil- r grubs, beetles, spiders, some fruit. Substrates: The rmal foliage of trees, generally feeding to 40 feet 2.m) high (MacArthur 1958). Techniques: Branch opping and foliage gleaning.

EY REFERENCES: Bent 1953, Bowdish and Philipp 1916, orkish 1929.

Nashville Warbler

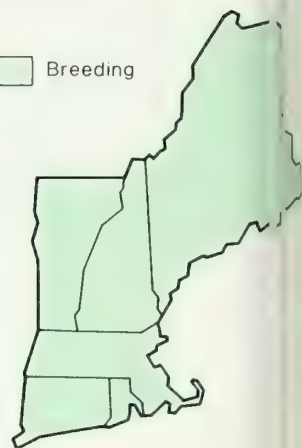
(*Vermivora ruficapilla*)

A.O.U. No. 645.0



Range

☐ Breeding



RANGE: Breeding: Southern Canada and n. United States. In the Northeast the range extends s. to Maryland (mountains) and rarely to Connecticut and Long Island. Winter: Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Moist open deciduous woods, overgrown pastures and fields, swampy areas, edges of woodlands, clearings with much young second-growth vegetation, especially young trees 10 to 12 feet tall (Pough 1949:158). Birds reportedly breed in both dry and moist situations, favoring spruce-sphagnum bogs in central New York (Bull 1974:477).

SPECIAL HABITAT REQUIREMENTS: Scattered trees interspersed with brush.

NESTING: Egg dates: May 19 to June 10, New York (Bull 1974:477). Clutch size: 3 to 5. Incubation period: 11 days. Nestling period: 11 to 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Depression in moss or beneath canopy of dried, dead bracken fern; well hidden.

TERRITORY SIZE: About 1/2 acre (0.2 ha) per pair in Ontario (Lawrence 1948).

SAMPLE DENSITIES: 39 territorial males per 100 acres (40 ha) in scrub spruce bog in Maryland. 21 territorial males per 100 acres (40 ha) in open hemlock-spruce bog in Maryland (Stewart and Robbins 1958:280).

FORAGING: Major foods: Adults, larvae, and eggs of various insects including small grasshoppers, planthoppers, caterpillars, and beetles. Substrates: Trunks, branches, and leaves of trees. Techniques: Hopping from bottom to the top of a tree hawking insects encountered.

COMMENTS: Flying insects sometimes taken in flycatcher fashion; mostly insectivorous (Griscom 1957:83).

KEY REFERENCES: Bent 1953, Forbush 1929, Griscom and Sprunt 1957, Lawrence 1948.


Northern Parula

(*Parula americana*)

D.U. No. 648.0



Range

 Breeding



RANGE: Breeding: Southern Canada to the Gulf States.
Winter: Central America and the West Indies.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Bent 1953:143).

HABITAT: Breeding: Wooded bogs, swamps, prefers
marshes in areas where bearded lichen (*Usnea*) grows.

SPECIAL HABITAT REQUIREMENTS: Prefers to nest in
bearded lichen or use the lichen as nesting material.

REPRODUCTION: Egg dates: May 17 to June 27, New York (Bull
1974:480). Clutch size: 3 to 7, typically 4 or 5. Incubation
period: 12 to 14 days. Nestling period: 11 days. Broods
per year: 1. Age at sexual maturity: 1 year. Nest height: 6
to 10 feet (1.8 to 3.0 m). Nest site: Usually hanging
at the distal end of a limb that is covered with *Usnea*.

POPULATION DENSITIES: Maryland — 47 territorial males per
100 acres (40 ha) in well-drained floodplain forest. 29
territorial males per 100 acres (40 ha) in poorly drained
floodplain forest. 19 territorial males per 100 acres (40
ha) in second-growth river swamp. 12 territorial males
per 100 acres (40 ha) in pine-oak forest (Stewart and Rob-
bins 1958:281).

FEEDING: Major foods: Beetles, plant-lice, inchworms,
and hairy caterpillars, spiders. Substrates: Branches,
twigs and leaves of trees. Techniques: Foliage and twig
pecking — often hangs upside down, chickadee fash-
ion.

COMMENTS: Composition of diet is 98 percent animal, 2
percent vegetable (Wetmore 1916 in Bent 1953:143).

KEY REFERENCES: Bent 1953, Forbush 1929, Graber and
Graber 1951.


Yellow Warbler

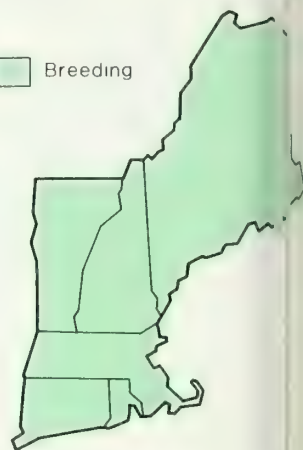
(*Dendroica petechia*)

A.O.U. No. 652.0



Range

 Breeding



RANGE: Breeding: Canada and Alaska to n. South America. Winter: Central and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Farmlands, orchards, roadsides and along streams and lakes.

SPECIAL HABITAT REQUIREMENTS: Scattered small trees or dense shrubbery.

NESTING: Egg dates: May 15 to July 3, New York (Bull 1974:481). Clutch size: 3 to 5, typically 4 or 5. Incubation period: 10 or 11 days. Nestling period: 9 to 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 15 feet (0.6 to 4.6 m). Typically 3 to 8 feet (0.9 to 2.4 m). DeGraaf and others (1975) found 19 Yellow Warbler nests at an average height of 22 feet (6.6 m) in five habitat types ranging from rural to urban in Massachusetts. Nest site: Securely placed in a fork or crotch of a shrub, sapling, or tree; often in stream-side thickets and shrubbery associated with suburban gardens. Adaptable in choice of nest site.

SAMPLE DENSITIES: 68 pairs per square mile (26 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 63 territorial males per 100 acres (40 ha) in shrubby field with stream-bordered trees in Maryland. 5 territorial males per 100 acres (40 ha) in field and edge habitat in Maryland (Stewart and Robbins 1958:282).

FORAGING: Major foods: Insects — caterpillars of many moths and brown-tail and tent caterpillars, cankerworms, beetles, weevils, plant-lice, and grasshoppers. Also takes spiders. Substrates: Small tree limbs generally to 40 feet (1.2 to 12.2 m) high (MacArthur 1958). Techniques: Branch hopping and gleaning, hawking.

COMMENTS: Food composition is 94 percent animal and 6 percent vegetable (Forbes 1883 in Bent 1953:171).

KEY REFERENCES: Bent 1953, Forbush 1929, Schantz 1943.


chestnut-sided Warbler

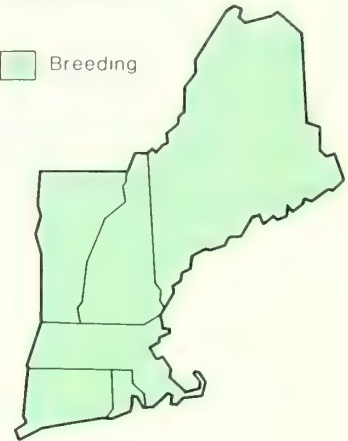
Dendroica pensylvanica)

O.U. No. 659.0



Range

 Breeding



AGE: Breeding: Southern Canada s. through mountainous uplands to e. Tennessee and n. Georgia. Winter: Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Second growth woodland edges and abandoned fields; along brushy brooksides and hill-sides, roadside thickets, woodland clearings and burns.

SPECIAL HABITAT REQUIREMENTS: Early second growth — shrubs and bush at wood margins, hardwood regeneration.

REPRODUCTION: Egg dates: May 20 to July 25, New York (Bull 1977:495). Clutch size: 4 to 5, typically 4. Incubation period: 12 to 13 days. Nestling period: 10 to 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 4 feet (0.3 to 1.2 m), typically 2 feet (0.6 m). Nest site: Well concealed in low bush, sapling, briars, or vines.

TERRITORY SIZE: Prior to mating, 4 territories measured 0.2, 0.3, 1.3, and 2.5 acres (0.5, 0.5, 0.5, 1.0 ha). During incubation, males increased territory size by 200 to 700 feet (61 to 213.4 m) to encompass 2 to 12 acres (0.8 to 4.9 ha). New York (Kendeigh 1945b).

POPULATION DENSITIES: 79 territorial males per 100 acres (40 ha) in dense second growth in Maryland. 67 territorial males per 100 acres (40 ha) in open slash (oak-maple) area (Stewart and Robbins 1958:294).

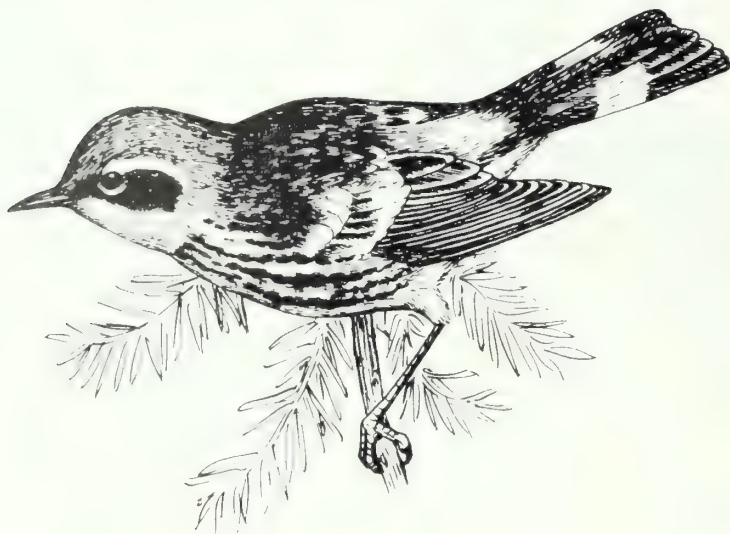
FORAGING: Major foods: Beetles, caterpillars, plant-lice, leaf hoppers, ants, spiders. Substrates: Foliage of shrubs or low plants to 35 feet (10.7 m) tall. Techniques: Hopping along branches and gleaning foliage.

KEY REFERENCES: Griscom and Sprunt 1957, Kendeigh 1945b, Lawrence 1948.


Magnolia Warbler

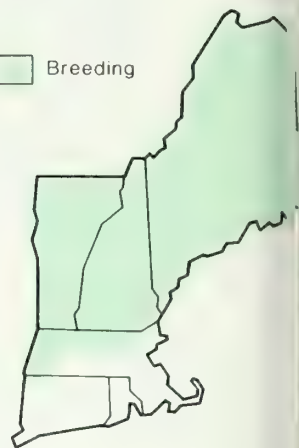
(*Dendroica magnolia*)

A.O.U. No. 657.0



Range

 Breeding



RANGE: Breeding: Newfoundland w. across Canada to c. Northwestern Territory, s. to c. British Columbia, Alberta, and e. to Wisconsin, s. Ontario and w. Massachusetts; southward in the mountains to sw. North Carolina. Winter: Mexico s. to Panama.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (mountains).

HABITAT: Breeding: Usually in small clumps of spruces or hemlocks, or in small coniferous saplings in old fields. Associated with woodland edges and clearings.

SPECIAL HABITAT REQUIREMENTS: Stands of young conifers.

NESTING: Egg dates: May 25 to July 11, New York (Bull 1974:482). Clutch size: 3 to 5, typically 4. Incubation period: 12 days. Nestling period: 10 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 1 to 35 feet (0.3 to 10.7 m). Typically 1 to 10 feet (0.3 to 3.0 m). Nest site: Commonly in young conifers, rarely in hardwoods, on a horizontal branch.

TERRITORY SIZE: 20 males had territories which averaged 1.8 acres (0.7 ha) in size — habitat: hemlock, beech in New York (Kendeigh 1945). Differences in breeding territory size occurred in different forest types: aspen — (average) 1.8 acres (0.7 ha); conifer-birch — (average) 2.2 acres (0.9 ha); mixed — (average) 2.4 acres (1.0 ha); maple — (average) 3.3 acres (1.3 ha) (Stenger and Falls 1959).

SAMPLE DENSITIES: 22 pairs per 40 ha (100 acres) Litch Island, Maine — forest is 83 percent red spruce, 14 percent white spruce; 15 pairs per 40 ha (100 acres) Moose Island, Maine — 100 percent white spruce; 42 pairs per 40 ha (100 acres) Harbor Island, Maine — 100 percent white spruce (Morse 1976). 80 males per 100 acres (40 ha) in virgin hemlock forest in Maryland. 63 males per 100 acres (40 ha) in open hemlock-spruce bog in Maryland. 33 males per 100 acres (40 ha) in scrub spruce (Stewart and Robbins 1958:283).

FORAGING: Major foods: Weevils, leaf-beetles, leafhoppers, plant lice, scale insects, ants, caterpillars, moths. Substrates: Branches of small trees or shrubs. Techniques: Twig and leaf gleaning.

COMMENTS: Mostly insectivorous (King 1883 in King 1953:204). In New York, birds inhabit forests at high elevations (Bull 1974:481).

KEY REFERENCES: Bent 1953, Forbush 1929, Kendeigh 1945, Morse 1976, Stenger and Falls 1959.

Cape May Warbler

(*Dendroica tigrina*)

D.U. No. 650.0



Range



RANGE: Breeding: Central and e. Canada, s. to n. Wisconsin, ne. New York, n. New Hampshire and n. Maine. Winter: West Indies n. to the Bahamas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (one).

HABITAT: Breeding: Fairly open coniferous forest with a high percentage of mature spruces; dense spruce forest with a scattering of taller spires above the canopy level; more open land among small trees.

ADDITIONAL HABITAT REQUIREMENTS: Tall stands of spruce.

BREEDING: Egg dates: June 10 to June 29. Peak: June 12 to June 20, New Brunswick (Bent 1953:224). Clutch size: 4 to 9, typically 6 or 7. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 60 feet (0.6 to 18.3 m). Nest usually 30 to 60 feet (9 to 18 m). Nest site: Usually in the top of a coniferous tree.

POPULATION DENSITIES: 28 pairs per 100 acres (40 ha) spruce forest near Lake Nipigon, Ontario (Kendeigh 1947 and Griscom and Sprunt 1957:118).

FEEDING: Major foods: Insects, ants, small adults and larvae of moths, flies, beetles, small crickets, termites, and larvae of dragonflies. Also takes spiders. Substrates: tops of dense branches and new buds of firs and spruces. Feeding techniques: Gleaning, hawking.

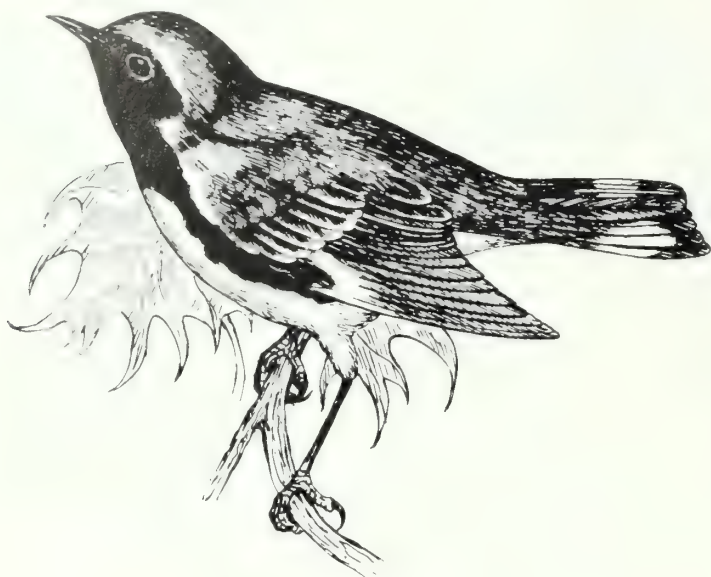
COMMENTS: Cape May Warblers are probably dependent on sporadic outbreaks of insects such as the spruce budworm that result in super-abundant food supplies (MacArthur 1958).

KEY REFERENCES: Forbush 1929, Griscom and Sprunt 1957, MacArthur 1958.


Black-throated Blue Warbler

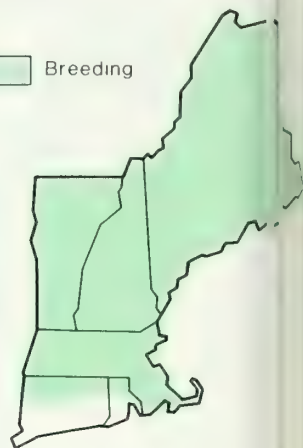
(*Dendroica caerulescens*)

A.O.U. No. 654.0



Range

 Breeding



RANGE: Breeding: Northern Minnesota, e. through Ontario, s. Quebec and Nova Scotia, s. to Connecticut and the mountains of Georgia. Winter: West Indies.

KEY REFERENCES: Bent 1953, Griscom and Sprunt 1957, Nice 1930.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Commonly found in or near mixed and deciduous forests with heavy undergrowth or at edges of woodland clearings generally in moist places.

SPECIAL HABITAT REQUIREMENTS: Woodlands with thick, shrubby undergrowth (Pough 1949:164).

NESTING: Egg dates: May 29 to July 16, New York (Bull 1974:484). Clutch size: 4 to 5. Incubation period: 12 days. Nestling period: 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 4 inches (10 cm) to 20 feet (6.1 m), New York (Bull 1974:484). Nest site: In coniferous or deciduous trees, or in shrubs.

SAMPLE DENSITIES: Maryland — 58 territorial males per 100 acres (40 ha) in virgin hemlock forest. 48 territorial males per 100 acres (40 ha) in young second growth. 17 territorial males per 100 acres (40 ha) in scrub spruce bog (Stewart and Robbins 1958:286).

FORAGING: Major foods: Insects — mainly hairy caterpillars, moths, crane-flies, mosquitoes, plant-lice. Substrates: Upper branches. Techniques: Hawking, branch and twig gleaning.

COMMENTS: Considered a deep woods Warbler, but also common in clearcuts after 15 years.

Yellow-rumped Warbler

(*Dendroica coronata*)

C.O.U. No. 655.0



Range



SIZE: Breeding: Alaska and Canada s. to Massachusetts (Berkshires), Pennsylvania (Poconos), and New York (Catskills). Winter: Central New England, s. through the United States, Central America, Bermuda, Bahamas, and the Virgin Islands.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common under at higher elevations.

HABITAT: Breeding: Coniferous woods (especially in spruce-fir) or in young coniferous growth near the edges of woods; sometimes in mixed woods. Wintering: Along the coast in any type of woodland, in thickets, gardens.

SPECIAL HABITAT REQUIREMENTS: Coniferous trees (summer), bayberry thickets (winter).

REPRODUCTION: Egg dates: May 19 to July 10, New York (Bull 1974:486). Clutch size: 3 to 5, typically 4. Incubation period: 12 to 13 days. Nestling period: 12 to 14 days. Breeds per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 4 to 50 feet (1.2 to 15.2 m). Typically 15 to 20 feet (4.6 to 6.1 m). Nest site: Usually in a small coniferous tree typically saddled on a branch of spruce, hemlock, or cedar. Sometimes in a deciduous tree such as maple or birch.

POPULATION DENSITIES: 30 pairs per 40 ha (100 acres) Loud's Island, Maine, 83 percent red spruce and 14 percent white spruce (Morse 1976). 39 pairs per 40 ha (100 acres) Main Island, Maine, 100 percent white spruce (Morse 1976). 31 pairs per 40 ha (100 acres) Harbor Island, Maine, 100 percent white spruce (Morse 1976).

FORAGING: Major foods: Insects in summer—plant lice, caterpillars, small grubs, ants, and leaf beetles. In winter—eggs and larvae of some insects, bayberries, berries of red cedar, woodbine, viburnums, honeysuckle, mountain ash, poison ivy, and so on. Substrates: Trunks and branches from tops of trees to ground level, air. Techniques: Trunk and branch gleaning and hawking.

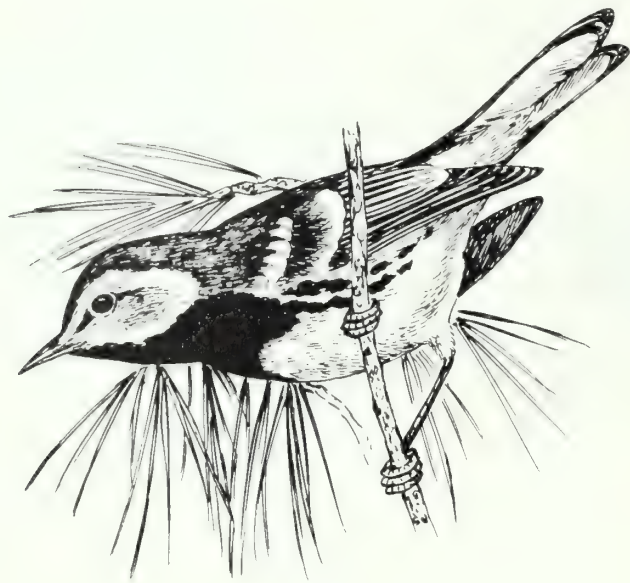
COMMENTS: Also uses evergreen plantations (New York) (Bull 1974:486).

KEY REFERENCES: Bent 1953, Forbush 1929, MacArthur 1958, Morse 1976.


Black-throated Green Warbler

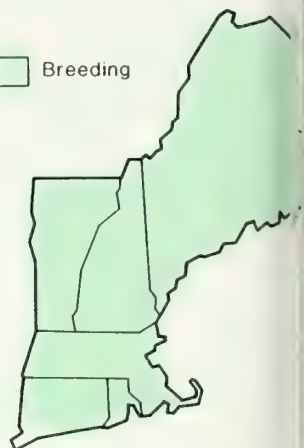
(*Dendroica virens*)

A.O.U. No. 667.0



Range

 Breeding



RANGE: Breeding: Central Canada to c. New Jersey and s. in the mountains to Alabama and Georgia. Winter: Southern Texas and sc. Florida, s. to Greater Antilles, e. Mexico to Panama.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Usually in hemlocks, but sometimes in other northern conifers: pine, spruce, fir, and cedar. Rarely in maples, birches, and other hardwoods.

SPECIAL HABITAT REQUIREMENTS: Coniferous or mixed woodlands.

NESTING: Egg dates: May 24 to July 2, New York (Bull 1974:489). Clutch size: 4 to 5, typically 4. Incubation period: 12 days. Nestling period: 8 to 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 70 feet (0.3 to 21.3 m). Typically 15 to 20 feet (4.6 to 6.1 m). Nest site: Usually on a horizontal or drooping branch.

TERRITORY SIZE: 21 territories ranged from 0.6 to 2.5 acres (0.2 to 1.0 ha); average size 1.6 acres (0.6 ha) (New York) (Kendeigh 1945); habitat: hemlock-beech.

SAMPLE DENSITIES: 71 pairs per 40 ha (100 acres) Loud's Island, Maine; 83 percent red spruce, 14 percent white spruce (Morse 1976). 61 pairs per 40 ha (100 acres) Marsh Island, Maine 100 percent white spruce (Morse 1976). 83 pairs per 40 ha (100 acres) Harbor Island,

Maine, 100 percent white spruce (Morse 1976). 36 territorial males per 100 acres (40 ha) in mature oak-maple forest in Maryland. 9 territorial males per 100 acres (40 ha) in mature northern hardwood forest (Stewart and Robbins 1958:288).

FORAGING: Major foods: Insects—leaf rollers, leaf-mining caterpillars, beetles, flies, gnats, and plant lice. Also takes mites, cankerworms, spiders, some berries. Forages: Often limbs and foliage of evergreens 10 to 30 feet (3.0 to 15.2 m) above ground. Techniques: Flitting, rapid peering or hovering followed by gleeful, occasional hawking.

COMMENTS: Strongly associated with hemlocks.

KEY REFERENCES: Forbush 1929, Kendeigh 1945, Morse 1976, Arthur 1958, Morse 1976.

Blackburnian Warbler

(*Dendroica fusca*)

D.O.U. No. 662.0



Range



RANGE: Breeding: Southern Canada to nw. Connecticut, se. New York and n. New Jersey s. to the mountains of South Carolina. Winter: Southern Central America, Central South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common, especially in higher elevations.

HABITAT: Breeding: Deep coniferous woods or swampy woods where spruces are thickly draped with bearded lichen (*Usnea*); often associated with very tall hemlocks; said to inhabit stands of second growth deciduous woods.

SPECIAL HABITAT REQUIREMENTS: Coniferous woodlands.

REPRODUCTION: Egg dates: June 1 to June 24, New York (Bull 1944:492). Clutch size: 4 to 5, typically 4. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 5 to 34 feet (1.5 to 25.6 m). Typically 30 to 50 feet (9.1 to 15.2 m). Nest site: High up in a tree (usually a spruce) situated away from the trunk or in small fork near top of tree.

TERRITORY SIZE: 9 territories averaged 1.3 acres (0.5 ha) in size per pair in New York; habitat: hemlock-beech (Kendeigh 1945).

SAMPLE DENSITIES: 26 pairs per 40 ha (100 acres) Loud's Island, Maine, 83 percent red spruce, 14 percent white spruce (Morse 1976). 17 pairs per 40 ha (100 acres) Marsh Island Maine, 100 percent white spruce (Morse

1976). 100 territorial males per 100 acres (40 ha) in virgin hemlock forest in Maryland. 96 territorial males per 100 acres (40 ha) in virgin spruce-hemlock bog forest in Maryland. 39 territorial males per 100 acres (40 ha) in scrub spruce bog in Maryland (Stewart and Robbins 1958:291).

FORAGING: Major foods: Almost entirely insects such as beetles, caterpillars, ants, crane-flies. Substrates: High tree limbs. Techniques: Passing from limb to limb with rapid gleaning, occasionally hovering or hawking.

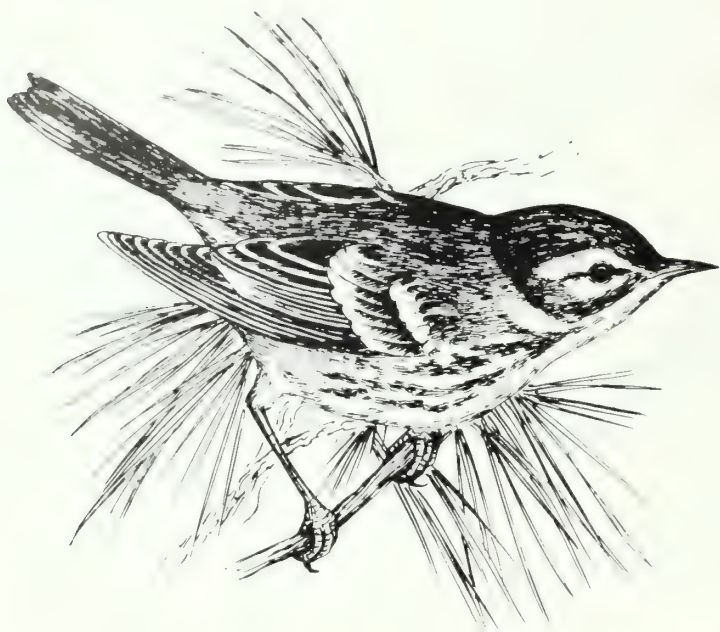
COMMENTS: Considered a deep-woods warbler; lives in the the tops of northern conifers, especially spruces.

KEY REFERENCES: Bent 1953, Griscom and Sprunt 1957, Kendeigh 1945, MacArthur 1958, Morse 1976.


Pine Warbler

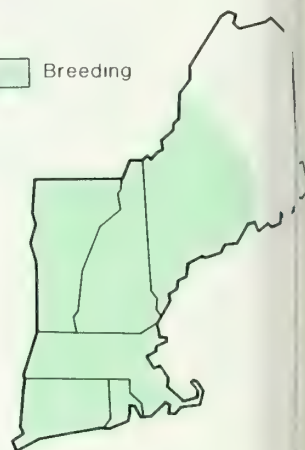
(*Dendroica pinus*)

A.O.U. No. 671.0



Range

 Breeding



RANGE: Breeding: Southern edge of Canada to the Gulf States. Winter: In the s. third of breeding range; some strays may be found as far n. as Massachusetts.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to rare.

HABITAT: Breeding: Exclusively in pines, favoring open pitch pine woods with tall trees. Frequents coastal pine barrens, less common inland. Wintering: Mature loblolly pine stands, especially those near tidewater.

SPECIAL HABITAT REQUIREMENTS: Pines. Pitch pine is preferred but other species of pine are used as well.

NESTING: Egg dates: May 4 to June 6, New York (Bull 1974:502). Clutch size: 3 to 5, typically 4. Incubation period: Probably 12 to 13 days (period unknown). Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 8 to 800 feet (2.4 to 24.4 m). Typically 30 to 50 feet (9.1 to 15.2 m). Nest site: saddled on a horizontal branch well out from the trunk; sometimes situated among the small twigs towards the end of a limb, obscured from below by a cluster of pine needles.

SAMPLE DENSITIES: Maryland—76 territorial males per 100 acres (40 ha) in immature loblolly-shortleaf pine stand. 20 territorial males per 100 acres (40 ha) in pine-oak forest. 10 territorial males per 100 acres (40 ha) in mature scrub pine (Stewart and Robbins 1958:297).

FORAGING: Major foods: Insects—adult and larvae of beetles, ants, grasshoppers, moths, bugs, flies, and scale insects. Also takes spiders and small amount of pine and birch seeds, berries of wax myrtle. Substrates: Trunks and larger branches of pines. Techniques: Trunk and branch gleaning.

COMMENTS: Generally associated with pines, especially pitch, loblolly and Virginia where they occur within its breeding range in the Northeast. Distribution is spotty.

KEY REFERENCES: Bent 1953, Forbush 1929.

Parula Warbler

(*Dendroica discolor*)

O.U. No. 673.0



Range

 Breeding



RANGE: Breeding: Northern Michigan, s. Ontario, c. New York and c. New England, s. Winter: Throughout the West Indies.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Open sandy or gravelly areas with scattered pitch pines, scrub oaks and other plants with similar requirements; prefers barren lands, dry, rocky brushy pasture, and dry sproutland often with scattered redcedars. Young stands of pine 10 to 30 feet (3 to 9 m) tall (Robbins et al. 1966:268) and deciduous saplings. Logging and burning create favorable habitat.

SPECIAL HABITAT REQUIREMENTS: Favors coniferous cover. Avoids high elevations.

REPRODUCTION: Egg dates: May 25 to June 29, New York (Bull 194:505). Clutch size: 3 to 5, typically 4. Incubation period: 10 to 14, typically about 12 days (Nolan 1978:235). Nestling period: 8 to 11 days, typically 9 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: Less than 1 foot (0.3 m) to 45 feet (13.7 m). Typically 3.3 to 6.6 feet (1.0 to 2.0 m) (Nolan 1978:127). Nest site: usually well hidden in upright fork of sapling or shrub. Less frequently in vines. American elm, sugar maple, hawthorn, scrub oak, and bayberry are important nest plants (Nolan 1978:133, Bent 1953:431).

TERRITORY SIZE: Maximum territories ranged in size from 0.4 to 3.5 ha (1 to 9 acres). Average 1.6 ha (0.6 acres) in Indiana (Nolan 1978:332).

FORAGING: Major foods: Larvae and adults of beetles, bugs, butterflies and moths, wasps, bees, flies, and grasshoppers. Also takes spiders. Substrates: Trees, saplings, shrubs, herbaceous vegetation, bare ground, air. Techniques: Branch, twig and leaf gleaning; flycatching; hovering; clinging to vertical stems; dropping to ground.

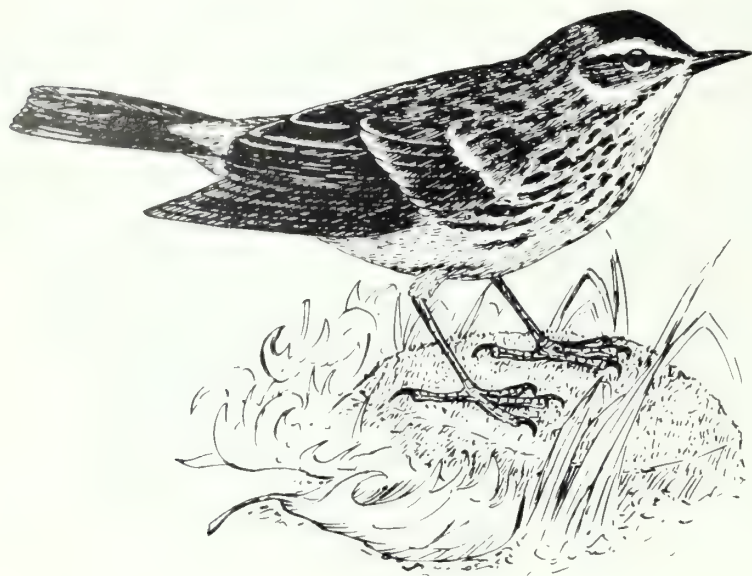
COMMENTS: Breeding range is expanding northward—influenced to a great extent by availability of Christmas tree plantations (Harrison 1975:196).

KEY REFERENCES: Bent 1953, Forbush 1929, Nolan 1978.

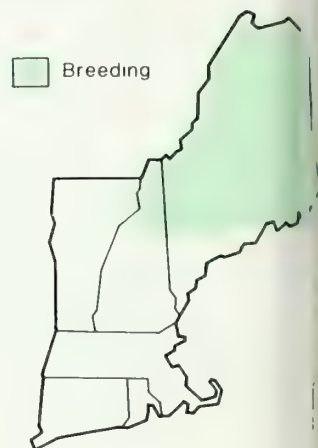
Palm Warbler

(*Dendroica palmarum*)

A.O.U. No. 672.0



Range



RANGE: Breeding: Southeastern Canada to c. Maine and c. New Hampshire. Winter: Southeastern United States casually n. along coast to New Jersey and Connecticut.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon in breeding season. Rare in winter.

HABITAT: Breeding: Frequents sphagnum bogs and wet muskegs, open barrens, and dry spruce forests.

NESTING: Egg dates: May 18 to June 8, Nova Scotia (Bent 1953:449). Clutch size: 4 to 5. Incubation period: 12 days. Nestling period: 12 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: A dry spot on ground such as a hummock where nest is concealed by grasses or other nearby vegetation; rarely on low branches of small spruce trees. Nests singly or in loose colonies.

FORAGING: Major foods: Mainly insects such as beetles, ants, caterpillars, grasshoppers, gnats, mosquitoes, flies, and mayflies. Vegetable matter, especially barberries during the winter months. Substrates: On the ground, in the air. Technique; Hawking.

KEY REFERENCES: Bent 1953, Forbush 1929, Walkinshaw and Wolf 1957.

Bay-breasted Warbler

(*Dendroica castanea*)

U. No. 660.0



Range

 Breeding



NE: Breeding: Central Canada to ne. New York, c. front and New Hampshire and s. Maine. Winter: central and e. Panama to n. Colombia and w. Venezu-

COMMENTS: Bay-breasted warblers may depend on periodic outbreaks of abundant insects such as the spruce budworm (MacArthur 1958).

RELATIVE ABUNDANCE IN NEW ENGLAND: Fairly common in e.

KEY REFERENCES: Chapman 1907, Forbush 1929, Griscom and Sprunt 1957, Mendall 1937.

HABITAT: Breeding: Northern coniferous or mixed forests, especially in young trees along ponds, streams, in major forest clearings.

ECOLOGICAL HABITAT REQUIREMENTS: Early coniferous seedling growth of trees 6 to 10 feet (1.8 to 3.4 m) tall (Pough 1944:174).

SINGING: Egg dates: June 5 to July 2, peak: June 17 to June 25, New Brunswick (Bent 1953:389). Clutch size: 4 to 7, typically 5 or 6. Incubation period: 12 to 13 days. Hatching period: 11 to 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 4 to 40 feet (1.2 to 12.2 m). Typically 15 to 25 feet (4.6 to 7.6 m). Nest site: usually a horizontal branch of a conifer or in the top of a deciduous tree, usually 5 to 10 feet (1.5 to 3.0 m) out from the trunk.

FORAGING: Major foods: Locusts, caterpillars, ants, beetles, leafhoppers, houseflies, spiders. Substrates: foliage of trees at all heights but mainly in interior of tree canopy. Techniques: Searching and foliage gleaning with deliberate movements, often spending much time in one place (MacArthur 1958). Occasionally hangs upside down. Rarely hovers.


Blackpoll Warbler

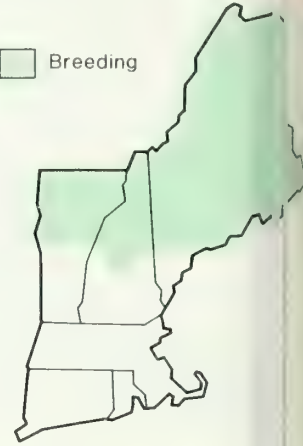
(*Dendroica striata*)

A.O.U. No. 661.0



Range

 Breeding



RANGE: Breeding: Edge of timber from nw. and s. Alaska across to Newfoundland, s. to s. Nova Scotia, and islands off e. Maine; New England mountains. Winter: Northern South America to e. Brazil.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common, local on Mt. Greylock (Massachusetts) (Bull 1974:497).

HABITAT: Breeding: Among low coniferous trees at high elevations, often in swampy groves, in stunted spruce and fir on the upper slopes of mountains. Favors small growth (stunted, young or medium-sized conifers).

SPECIAL HABITAT REQUIREMENTS: Low coniferous growth.

NESTING: Egg dates: June 5 to July 10, New York (Bull 1974:499). Clutch size: 3 to 5, typically 4 or 5. Incubation period: 11 to 12 days. Nestling period: 10 to 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 12 feet (0.3 to 3.7 m). Typically 5 feet (1.5 m). Nest site: Usually low in a spruce or other conifer; rarely on the ground.

FORAGING: Major foods: Insects such as spruce-gall lice, cankerworms, mosquitoes, fall webworms, locusts, ants, gnats; some seeds and berries. Substrates: Leaves and twigs. Techniques: Foliage gleaning.

KEY REFERENCES: Bent 1953, Forbush 1929.


Cerulean Warbler

(*Dendroica cerulea*)

O.U. No. 658.0



Range

 Breeding



RANGE: Breeding: In the East from se. Ontario and c. New York, s. Also found in Sandbar State Park, Vermont. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common at low elevations in the Champlain Valley.

HABITAT: Breeding: Swamps and bottomlands. Favors open stands of tall trees along riverbanks or dense deciduous forests with little undergrowth. Generally occupies upper canopy.

SPECIAL HABITAT REQUIREMENTS: Tall deciduous trees.

REPRODUCTION: Egg dates: May 19 to June 23, New York (Bull 1974:490). Clutch size: 3 to 5, typically 4. Incubation period: 12 to 13. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 20 to 60 feet (6.1 to 18.3m). Nest site: Usually in the fork of a tall tree, some distance from the trunk with an open area below. Elm was a favorite nest tree in New York State (Bull 1974:490).

POPULATION DENSITIES: 4.8 territorial males per 20 ha (50 acres) in birch-basswood habitat in Pennsylvania (Van Vliet 1977).

FEEDING: Major foods: Mainly insects such as wasps, bees, beetles, weevils, and caterpillars. Substrates: Air, leaves. Techniques: Hawking, foliage gleaning.

COMMENTS: Eats chiefly insects (Griscom 1957:151).

KEY REFERENCES: Bent 1953, Forbush 1929, Griscom and Sprunt 1957, Linehan 1973.

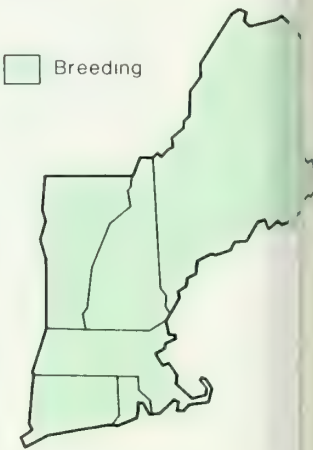
Black-and-white Warbler

(*Mniotilta varia*)

A.O.U. No. 636.0



Range

 Breeding

RANGE: Breeding: Southern Canada, s. to n. Mississippi, c. Alabama, c. Georgia, s. South Carolina, and se. North Carolina. Winter: From Baja, California, s. Texas, c. Florida, and the Bahamas, s. through Central America and the West Indies to n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Mature or second-growth deciduous or mixed woodlands from near sea level to mountain peaks. Not abundant in northern coniferous forests.

NESTING: Egg dates: May 10 to June 30, New York (Bull 1974:463). Clutch size: 4 to 5, typically 5. Incubation period: 13 days. Nesting period: 11 to 12 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: A depression in the ground at the base of a tree, stump or over-turned roots, rock or in the shelter of a log, usually hidden from above.

SAMPLE DENSITIES: Maryland—21 territorial males per 100 acres (40 ha) in dense second growth. 13 territorial males per 100 acres (40 ha) in open slash area. 11 territorial males per 100 acres (40 ha) in virgin hardwood forest (Stewart and Robbins 1958:270).

FORAGING: Major foods: Wood boring insects, click beetles, plant lice, small caterpillars, moths, spiders, egg masses, and pupae. Substrates: Bark crevices of

tree trunks and main branches, generally to 35 feet (10.7 m) high (MacArthur 1958). Techniques: creeping and bark-gleaning.

COMMENTS: One of the earliest warblers to arrive on northern breeding grounds in spring.

KEY REFERENCES: Forbush 1929, Griscom and Spent 1957, Harrison 1975.


American Redstart

Setophaga ruticilla)

O.U. No. 687.0



Range

 Breeding



RANGE: Breeding: From limit of tree growth, s. to Oregon, Arkansas, North Carolina, and the mountains of Georgia. Winter: Mexico and the West Indies to Ecuador and British Guiana.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: In orchards, saplings bordering on pastures, second-growth deciduous woodlands (occasionally coniferous or mixed); in shade trees and shrubbery about dwellings, second-growth maples; also in willow and alder thickets bordering ponds and streams. Most abundant in extensive, sapling/pole stage deciduous woodlands (Bond 1957).

REPRODUCTION: Egg dates: May 22 to July 16, New York (Bull 1974:522). Clutch size: 3 to 5, typically 4. Incubation period: 12 to 14 days. Nestling period: 8 to 9 days. Eggs per year: 1. Age at sexual maturity: 1 year. Nest height: 4 to 30 feet (1.2 to 9.1 m). Nest site: In upright crotch of a tree or on a horizontal limb, sapling, or shrub.

TERRITORY SIZE: Slightly less than 1 acre (0.4 ha) per pair (Griscom and Sprunt 1957:241); 1 acre (0.4 ha) or less per pair (Hickey, in Bent 1953); 0.8 acres (0.3 ha) per male (Ficken 1962); 6 territories on 1.4 acres (0.6 ha) (average 0.24 acres, 0.1 ha); 9 territories on 1.4 acres (0.6 ha) (average 0.16 acres, 0.1 ha) in orchard, second-growth woodland comprised of sugar maple, basswood,

hackberry, black cherry, and elm with younger trees and sumac as understory along western Lake Erie (Sturm 1945).

SAMPLE DENSITIES: 7 males were sighted 10 to 20 m (33 to 66 feet) apart in area 100 m² (120 square yard) (Baker 1944) in a thick stand of young sugar maples (saplings) with a scattering of large deciduous trees. 36 pairs per 40 ha (100 acres) Harbor Island, Maine, in white spruce (Morse 1976). 51 territorial males per 100 acres (40 ha) in well-drained floodplain forest in Maryland, and 91 territorial males per 100 acres (40 ha) in second-growth river swamp (Stewart and Robbins 1958:316).

FORAGING: Major foods: Insects such as caterpillars, bugs, flies, moths, small grasshoppers, beetles, and wasps. Also takes spiders and small amounts of fruit. Substrates: Dead tree limbs, foliage, air. Generally feeds at heights between 5 and 50 feet (1.5 and 15.2 m) (MacArthur 1958). Techniques: Branch and twig gleaning, hawking.

KEY REFERENCES: Bent 1953, Forbush 1929, Griscom and Sprunt 1957.


Prothonotary Warbler

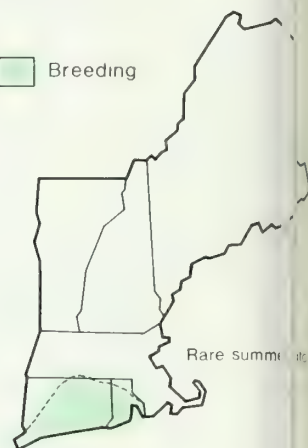
(*Protonotaria citrea*)

A.O.U. No. 637.0



Range

 Breeding



RANGE: Breeding: Southeastern Minnesota and ne. Nebraska e. to s. Ontario, c. New York and c. New Jersey s. to Florida. Winter: Nicaragua to Colombia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Wooded swamps, borders of streams and shallow ponds and flooded bottomlands often heavily shaded with oak, maple, ash, and elm.

SPECIAL HABITAT REQUIREMENTS: Cavity for nesting; border between water and thick deciduous woods (Simpson 1969).

NESTING: Egg dates: May 17 to June 29, New York (Bull 1974:464). Clutch size: 3 to 8, typically 6. Incubation period: 12 to 14 days. Nesting period: 10 or 11 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 3 to 32 feet (1.0 to 9.8 m). Typically 5 to 10 feet (1.5 to 3.0 m). Nest site: Natural cavities, abandoned woodpecker holes or nest boxes. Almost always in well-shaded stumps or snags that are standing in water or less than 20 feet (6 m) from it (Simpson 1969). Male builds one or two dummy nests.

TERRITORY SIZE: Linear—240 to 300 m (792 to 990 feet) of woody vegetation at water's edge (Simpson 1969). An area 168 (552 feet) long by 61.0 m (201 feet) wide was occupied by one male (Tennessee) (Meyer and Nevius 1943). Habitats: grassy terraces (with several nesting boxes); river banks densely covered with small trees and bushes.

SAMPLE DENSITIES: 40 territorial males per 100 acres (40 ha) in second-growth river swamp in Maryland (Stewart and Robbins 1958:272). Maximum 27 pairs per 4 ha (100 acres) (Hardin and Evans 1977).

FORAGING: Major foods: Caterpillars, ants, flies, bees, locusts, aquatic insects, beetles, spiders, small snails. Substrates: Trunks and branches of trees. Techniques: Trunk and branch gleaning.

COMMENTS: Highly insectivorous (Bent 1953:25).

KEY REFERENCES: Griscom and Sprunt 1957; Simpson 1969, Walkinshaw 1938b, 1953.


Worm-eating Warbler

(*elmitheros vermivorus*)

O.U. No. 639.0



Range

 Breeding



RANGE: Breeding: From s. New England, w. New York, n. Indiana, and s. Iowa, s. to Virginia, n. Georgia, and s. Missouri. Winter: The Bahamas, the West Indies, and Central America. Rarely n. to Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common (Lower Hudson Valley) to rare (north shore of Long Island) (Bull 1974:466).

HABITAT: Breeding: Deep, damp woods, wooded ravines on hillsides often near a running stream and a dense understory. Birds favor second-growth deciduous woods with young trees and a shrubby understory (Pough 199:149).

SOCIAL HABITAT REQUIREMENTS: Dense undergrowth.

NOTING: Egg dates: May 24 to June 18, New York (Bull 1974:466). Clutch size: 3 to 6, typically 4 to 5. Incubation period: 13 days. Nestling period: 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On ground often at base of tree, rock, or log. On hillsides or banks of ravines.

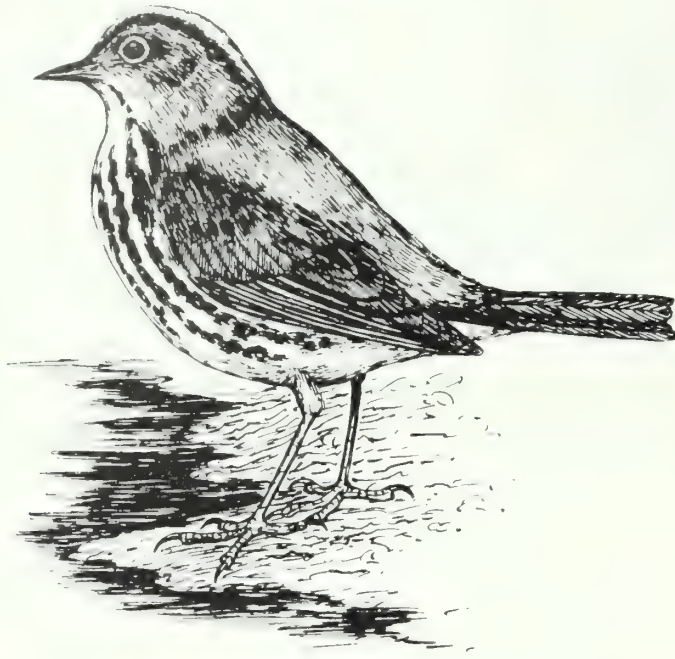
FRAGING: Major foods: Mainly insects, takes few worms. Substrates: Leaf litter of forest floor. Techniques: Ground gleaning.

REFERENCES: Bent 1953, Forbush 1929.

Ovenbird

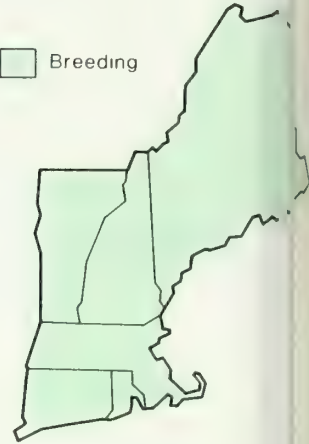
(*Seiurus aurocapillus*)

A.O.U. No. 674.0



Range

 Breeding



RANGE: Breeding: Central Canada and the ne. United States, s. in the mountains to Georgia. Winter: Florida w. to Mexico, s. to Central America, the West Indies and n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Usually in closed-canopy, mature deciduous or mixed woods, but often among pines; open forests with little underbrush and an abundance of fallen leaves, logs, and rocks are preferred. Thinning may reduce ovenbird abundance until the canopy closes (Johnston 1970).

NESTING: Egg dates: May 17 to July 22, New York (Bull 1974:507). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 12 days. Nestling period: 8 to 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On ground (sloped or level), in depression of dead leaves, sometimes at base of tree or log, invariably roofed over and concealed from above by vegetation.

TERRITORY SIZE: 0.5 to 4.5 acres (0.2 to 1.8 ha) per pair (Hann 1937); 21 territories averaged 1.6 acres (0.6 ha), range 0.25 to nearly 3 acres (0.1 to 1.2 ha) — habitat: hemlock-beech (Kendeigh 1945).

SAMPLE DENSITIES: Maryland — 40 territorial males per 100 acres (40 ha) in mixed oak forest. 26 territorial males per 100 acres (40 ha) in dense second growth. 24 territorial males per 100 acres (40 ha) in young second growth

(resulting from cutting). 17 territorial males per 100 acres (40 ha) in pine-oak forest (Stewart and Roalson 1958:302).

FORAGING: Major foods: Insects such as plant lice, caterpillars (hairy and hairless), other larvae, moths, beetles, flies, grasshoppers, and crickets. Also consumes small snails, slugs, myriapods, earthworms, and spiders. Substrates: Leaf litter and debris of forest floor. Technique: Ground gleaning.

COMMENTS: Pairs may mate in successive years (Bent 1953:458).

KEY REFERENCES: Bent 1953, Forbush 1929, Hann 1937.

Northern Waterthrush

(*Pipilo noveboracensis*)

A.O.U. No. 675.0



Range



RANGE: Breeding: Southern Quebec, Labrador, and Newfoundland, s. to se. New York, West Virginia, and Pennsylvania (in Appalachians), s. New England. Winter: Mainly from Mexico and the West Indies s. to n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to common (widespread).

HABITAT: Breeding: Favors wooded swamps and bogs, less frequently occurs along woodland brooks or streams and swampy wooded shores of ponds or lakes. Commonly breeds at moderately high elevations.

SOCIAL HABITAT REQUIREMENTS: Cool, shady, wet ground with open pools of shallow water (Pough 199:181).

NOTING: Egg dates: May 10 to June 28, New York (Bull 174:509). Clutch size: 4 to 5. Incubation period: 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: In cavity on the ground: among roots of fallen trees, at base of moss-covered stump, under mossy log, on side of mossy brook bank.

SAMPLE DENSITIES: Maryland — 84 territorial males per 100 acres (40 ha) in open hemlock-spruce bog. 33 territorial males per 100 acres (40 ha) in scrub spruce bog (Stewart and Robbins 1958:303).

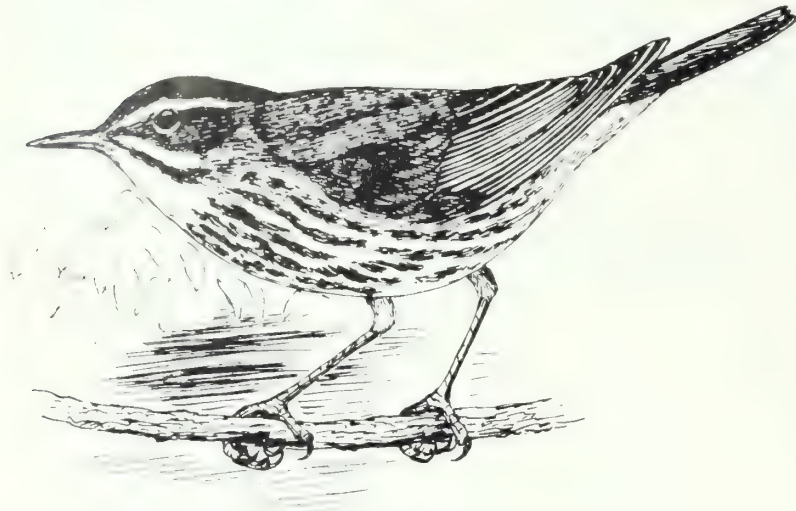
FORAGING: Major foods: Aquatic insects, beetle larvae, moths, mosquitoes, ants. Also takes small crustaceans, mollusks, and worms. Substrates: Crevices in rocks. Technique: Ground gleaning.

KEY REFERENCES: Forbush 1929, Griscom and Sprunt 1957.


Louisiana Waterthrush

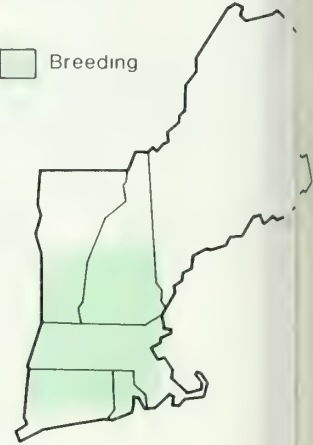
(*Seiurus motacilla*)

A.O.U. No. 676.0



Range

 Breeding



RANGE: Breeding: From c. Nebraska, e. to s. Ontario, Vermont, and New Hampshire, s. to e. Oklahoma, e. Texas, Louisiana, across to ne. North Carolina. Winter: From s. Sonora, Mexico, Cuba, Bahamas, and Bermuda, s. to Panama, Trinidad, Colombia, and Venezuela.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Bottomland forests where moss-covered logs and rank undergrowth give an almost tropical character to the surroundings; wooded valleys of rocky brooks or small streams; sometimes in woods. Favors wooded streams and brooks with swiftly flowing water. Avoids high elevations.

SPECIAL HABITAT REQUIREMENTS: Woodlands with flowing water, especially streams and brooks (Pough 1949: 182).

NESTING: Egg dates: April 25 to June 20, New York (Bull 1974:510). Clutch size: 4 to 7, typically 5. Incubation period: 12 to 14 days. Nestling period: 10 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 1 to 6 feet (0.3 to 1.8 m). Typically on ground. Nest site: In cavity in bank of stream or among upturned roots of a fallen tree.

SAMPLE DENSITIES: Maryland — 16 territorial males per 100 acres (40 ha) in second-growth river swamp. 4 territorial males per 100 acres (40 ha) in well-drained floodplain forest (Stewart and Robbins 1958:304).

FORAGING: Major foods: Dragonfly and crane fly larvae, beetles, bugs, ants, caterpillars, scale insects, spiders, and mollusks. Substrates: Sandy margins of streams. Technique: Ground gleaning.

KEY REFERENCES: Bent 1953, Chapman 1907, Eaton 193.

Mourning Warbler

Dporornis philadelphia)

O.U. No. 679.0



Range



RANGE: Breeding: Southeastern Canada s. to the Berkshires, Catskills, Poconos, and higher elevations of West Virginia and Virginia, n. Minnesota, Michigan. Winter: Central America and n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon breeder.

HABITAT: Breeding: Dense underbrush on the margin of a lowland swamp or bog; bushy hillsides, forest clearings grown up to brambles, shrubs and saplings.

SOCIAL HABITAT REQUIREMENTS: Extensive stands of dense saplings, shrubs (Pough 1949:185).

REPRODUCTION: Egg dates: May 28 to July 7, New York (Bull 194:514). Clutch size: 3 to 5, typically 4. Incubation period: 12 days. Nestling period: 7 to 9 days, or more (H. Harrison, personal communication). Broods per year: 1. Age at sexual maturity: 1 year. Nest height: To 2 feet (0.6 m rarely). Typically on ground. Nest site: On ground in tangles of briars, weeds, or grasses.

TERRITORY SIZE: 10 territories ranged from 1.6 to 2.4 acres (0.6 to 1.0 ha), average 1.9 acres (0.8 ha) in Minnesota (Cox 1960).

SAMPLE DENSITIES: 10 territorial males per 100 acres (40 ha) in dense second growth in Maryland (Stewart and Robins 1958:308).

FORAGING: Major foods: Beetles, lepidopterans, spiders. Substrates: Thick underbrush. Techniques: Ground, shrub, stem gleaning.

KEY REFERENCES: Bent 1953, Cox 1960, Griscom and Sprunt 1957.

Common Yellowthroat

(*Geothlypis trichas*)

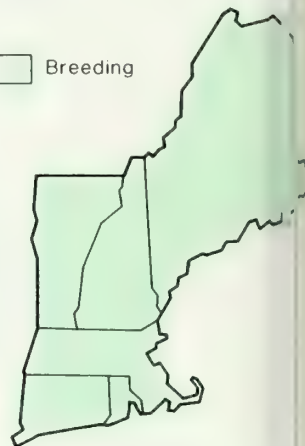
A.O.U. No. 681.0



Range



Breeding



RANGE: Breeding: Alaska and Canada s. to s. Mexico. Winter: Southern Maryland s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Wet brushy meadows and pastures, open swampy thickets on the margins of damp woods and woodland streams or ponds; in cattail beds of fresh or salt water marshes and dense tangles near water. Occasionally in dry thickets or dense undergrowth in open woodland.

NESTING: Egg dates: May 15 to July 12, New York (Bull 1974:515). Clutch size: 3 to 6, typically 4. Incubation period: 11 to 13 days. Nestling period: 9 to 10 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: To 3 feet (0.9 m). Typically on ground. Nest site: Among weeds, sedges or shrubs, in grassy tussocks, sometimes among ferns, or higher in low shrubs or tangles of briars.

TERRITORY SIZE: 0.8 to 1.8 acres (0.3 to 0.7 ha) per pair in the Geddes Marsh area (Michigan) (Stewart 1953); 7 pairs in 5 or 6 acres (2.0 to 2.4 ha), averaging less than 1 acre (0.4 ha) per pair in shrubby field habitat in New York (Kendeigh 1945).

SAMPLE DENSITIES: 9.7 males per square mile (4 males/km²) (Stewart 1953). 69 males per 100 acres (40 ha) (Stewart 1953). 1 pair per 2 acres (0.8 ha) (Hofslund 1957). 111 territorial pairs per acres (40 ha) in hedgerow bordering brook in Maryland (Stewart and Robbins 1958:309).

FORAGING: Major foods: Cankerworms, fall webworms, gypsy moths, caterpillars, grasshoppers, leafhoppers, plant lice, spiders. Substrates: Ground (in grasses); shrubs. Techniques: Shrub and ground gleaning.

KEY REFERENCES: Forbush 1929, Stewart 1953.

Wooded Warbler

(*Vilsonia citrina*)

A.O.U. No. 684.0



Range

☐ Breeding



RANGE: Breeding: Connecticut, c. New York, s. Michigan, n. Iowa, and se. Nebraska, s. to n. Florida and the Gulf Coast w. to Louisiana. Winter: Mexico to Panama.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Most often in brushy, swampy lowlands, less frequently at edges and interiors of well-watered mature deciduous woodlands with dense undergrowth or on rich, moist hillsides in thickets of laurel. Feeds lowlands.

SPECIAL HABITAT REQUIREMENTS: Low, dense, woody vegetation (deciduous).

REPRODUCTION: Egg dates: May 25 to July 10, New York (Bull 194:518). Clutch size: 3 to 5. Incubation period: 12 days. Nestling period: 8 days, probably more (H. Harrison, personal communication). Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 1 to 6 feet (0 to 1.8 m). Typically 2 to 3 feet (0.6 to 0.9 m). Nest site: Above ground in a bush, sapling, or herbaceous vegetation.

SAMPLE DENSITIES: Maryland — 32 territorial males per 100 acres (40 ha) in second-growth river swamp. 32 territorial males per 100 acres (40 ha) in young second growth. 17 territorial males per 100 acres (40 ha) in open slash area. 8 territorial males per 100 acres (40 ha) in upland oak forest (Stewart and Robbins 1958:313).

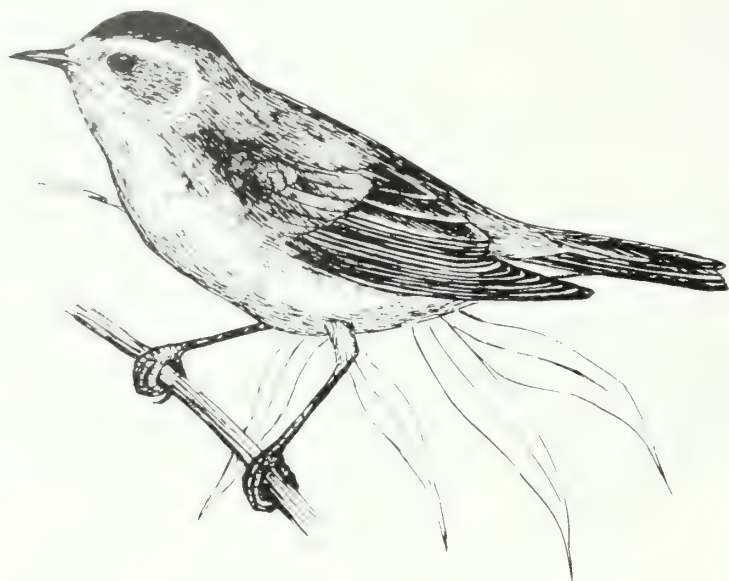
FORAGING: Major foods: Grasshoppers, locusts, caterpillars, plant lice, wasps, ants, moths, beetles, flies, bugs, caddis flies. Substrate: Air. Technique: Hawking.

KEY REFERENCES: Bent 1953, Forbush 1929.

Wilson's Warbler

(*Wilsonia pusilla*)

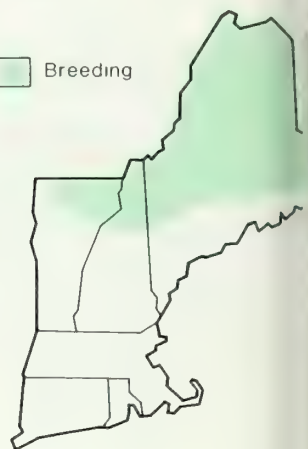
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Range



Breeding



RANGE: Breeding: Eastern Canada s. to c. Maine, n. New Hampshire, n. Vermont and n. Minnesota. Winter: Mexico s. to Panama.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Swampy, brushy land, such as tamarack bogs or swampy runs, willow and alder swales. Generally stays low, within 10 feet (3.0 m) of ground (Pough 1949:190).

NESTING: Egg dates: June 6 to June 21, New Brunswick (Bent 1953:639). Clutch size: 4 to 6, typically 5. Incubation period: 11 to 13 days. Nestling period: 10 to 11 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: On or sunken in the ground; usually among brushes, such as alders or smaller shrubs, or at base of sapling. May nest in loose colonies in favorable habitat.

TERRITORY SIZE: Mean 0.57 ha (1.4 acres), range 0.2 to 1.3 ha (0.5 to 3.2 acres); mean 0.48 ha (1.2 acres), range 0.3 to 1.0 ha (0.7 to 2.47 acres), in California (Stewart 1973).

FORAGING: Major foods: Flies, gnats, plant lice, small caterpillars, other larvae, small grasshoppers, spiders. Substrates: Twigs to 25 feet (7.6 m) above ground (MacArthur 1959). Techniques: Hopping and twig gleaning.

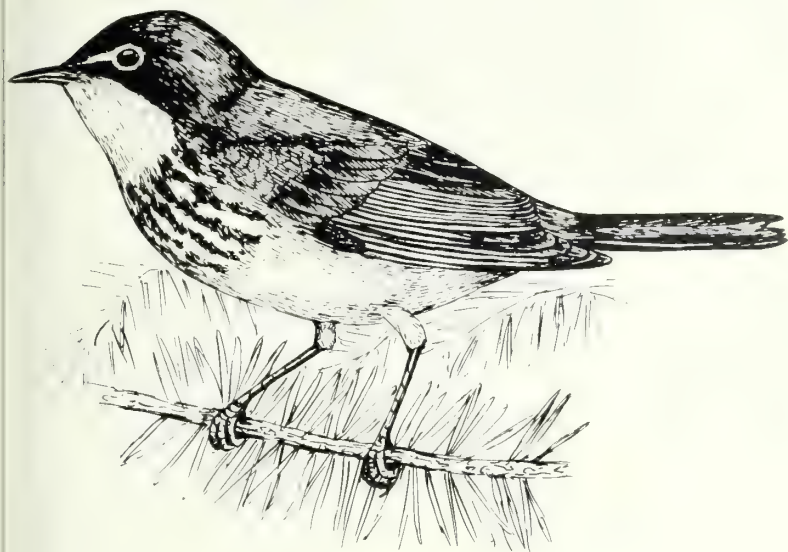
COMMENTS: Diet 93 percent insect (Beal 1907 in Bent 1953:630).

KEY REFERENCES: Bent 1953, Forbush 1929, Stewart 1973.

Canada Warbler

(*Wilsonia canadensis*)

A.D.U. No. 686.0



Range

 Breeding



RANGE: Breeding: Southern Canada to n. New Jersey
Maine, New York, s. in the mountains to Georgia. Rarely
s. New England coast. Winter: Central and South
America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine
and elsewhere at higher elevations).

HABITAT: Breeding: Occupies a variety of habitats from
lowlands to uplands, coniferous to deciduous. Favors
shrubby undergrowth in cool, moist, mature woodlands,
oak and cherry "burns," streamside thickets, cedar
swamps, weedy ravines and, less often, dry forest edge with
young trees.

REPRODUCTION: Egg dates: May 31 to June 30, New York (Bull
194:521). Clutch size: 3 to 5, typically 4. Broods per
year: 1. Age at sexual maturity: 1 year. Nest site: On or
near the ground, atop mossy logs or stumps, cavities in
logs or amid roots of windthrows, among fern stands.
Nests are usually in the vicinity of a stream, pond, or
other body of water.

TERRITORY SIZE: 1 male occupied a singing area of 0.6
acres (0.2 ha) until nesting began, at which time he ex-
panded his movements to 2 acres (0.8 ha). Another male
occupied 3 acres (1.2 ha) after nesting began (New York)
(Kendeigh 1945). Habitat: hemlock-beech.

SAMPLE DENSITIES: Maryland — 45 territorial males per
100 acres (40 ha) in dense oak-maple second growth. 32

territorial males per 100 acres (40 ha) in young second-
growth (after cutting). 21 territorial males per 100 acres
(40 ha) in open hemlock-spruce bog (Stewart and Rob-
bins 1958:315).

FORAGING: Major foods: Mosquitoes, flies, moths, bee-
tles, small hairless caterpillars, spiders. Substrates: Air,
leaf litter. Techniques: Hawking, ground gleaning.

COMMENTS: Diet consists wholly of insects and spiders.
The bird is an expert flycatcher.

KEY REFERENCES: Griscom and Sprunt 1957, Harrison
1975.

Yellow-breasted Chat

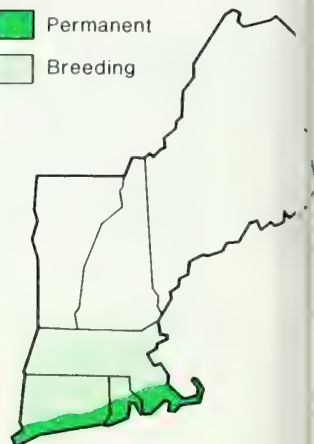
(*Icteria virens*)

A.O.U. No. 683.0



Range

- Permanent
- Breeding



RANGE: Breeding: Southern British Columbia e. to s. Ontario, and Massachusetts, s. to se. Texas, the Gulf states and n. Florida. Winter: Mexico and Central America to Panama; irregularly in small numbers to coastal sections of se. Massachusetts.

RELATIVE ABUNDANCE IN NEW ENGLAND: Local breeder from central Massachusetts south.

HABITAT: Breeding: Brushy pastures, thickets or briar patches, usually near water. Clearings with young growth resulting from logging or burning. Avoids high elevations. Wintering: Dense thickets.

SPECIAL HABITAT REQUIREMENTS: Dense shrubs and vines with scattered young trees, often near water.

NESTING: Egg dates: May 25 to July 13, New York (Bull 1974:516). Clutch size: 3 to 5, typically 4. Incubation period: 11 days (H. Harrison, personal communication). Broods per year: 1. Age at sexual maturity: 1 year. Nest height: To 5 feet (1.5 m), typically 3 feet (0.9 m). Nest site: In a bush, small sapling or tangle of grapevines, catbrier, brambles, and so on, occasionally on the ground.

TERRITORY SIZE: 1.2 to 2.5 acres (0.5 to 1.0 ha) per pair, though individuals may roam well into a neighboring territory. Habitat: grown-over abandoned fields in northern Virginia (Dennis 1958).

SAMPLE DENSITIES: Maryland — 36 territorial males per 100 acres (40 ha) in shrubby field with trees and stream; 28 territorial males per 100 acres (40 ha) in deciduous scrub (damp) with snags. 15 territorial males per 100 acres (40 ha) in dry deciduous scrub resulting from fire (Stewart and Robbins 1958:311).

FORAGING: Major foods: Beetles, bugs, ants, wasps, weevils, mayflies, various caterpillars including tent caterpillars and currant-worms, raspberries, whortleberries, wild strawberries, blackberries, wild grapes. Substrates: Brush and saplings. Techniques: Shrub stem and foliage gleaning.

COMMENTS: Diet is largely insects (Howell 1932 in Edwards 1953:591).

KEY REFERENCES: Bent 1953, Forbush 1929, Thompson and Nolan 1973.


Scarlet Tanager

(*Piranga olivacea*)

A.O.U. No. 608.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. through e. Maine to s. Saskatchewan, s. to the coast of Virginia and s. Kansas. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common and widespread.

HABITAT: Breeding: Mature deciduous and mixed woodlands, roadside shade trees. Often in pine-oak and oak-hickory woodlands. 68 percent of 28 nests in oak-hickory woods and tamarack swamp were in trees with a d.b.h. greater than or equal to 9 inches (23 cm) (Prescott 1965:21).

SPECIAL HABITAT REQUIREMENTS: Deciduous or mixed woodlands.

REPRODUCTION: Egg dates: May 20 to July 23, New York (Bull 1974:544). Clutch size: 3 to 5, typically 4. Incubation period: 13 to 14 days. Nestling period: About 15 days. Eggs per year: 1. Age at sexual maturity: 1 year. Nest height: 8 to 75 feet (2.4 to 22.9 m). Typically 20 to 35 feet (6 to 10.7 m). Nest site: Usually placed well out from trunk on a horizontal branch in a leaf cluster or position where it is shaded from above and open to the ground below. It is usually placed where it can be approached by unobstructed flyways from adjacent trees (Prescott 1965:20).

SAMPLE DENSITIES: Maryland — 26 territorial males per 100 acres (40 ha) in virgin central hardwood deciduous forest. 15 territorial males per 100 acres (40 ha) in mature

hardwood forest. 14 territorial males per 100 acres (40 ha) in dense second-growth (oak-maple) forest (Stewart and Robbins 1958:331).

FORAGING: Major foods: Insects, fruits. Substrates: Leaves and twigs of outer tips of limbs, dead branches. Techniques: Twig and leaf gleaning, flight-gleaning. Preferred feeding habitat: Canopy of forest trees.

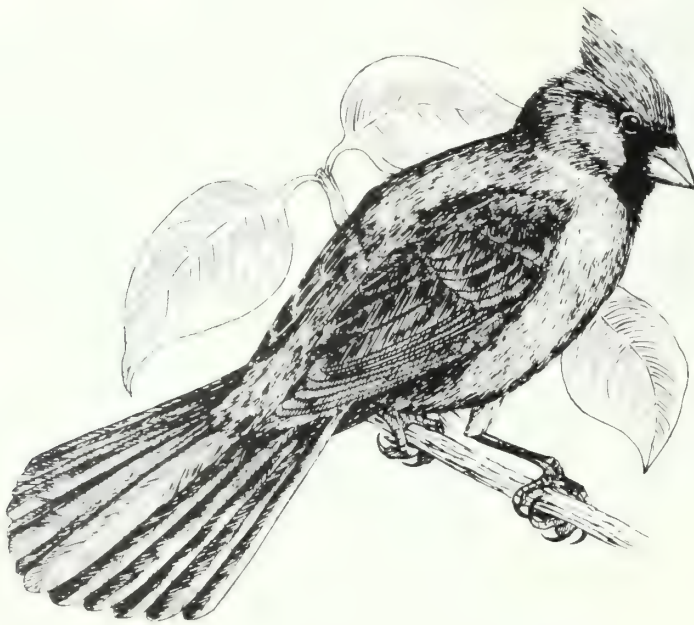
COMMENTS: Seven-eighths of the diet is animal, and one-eighth is vegetable (McAtee 1929 in Bent 1958:485).

KEY REFERENCES: Bent 1958, Prescott 1965.

Northern Cardinal

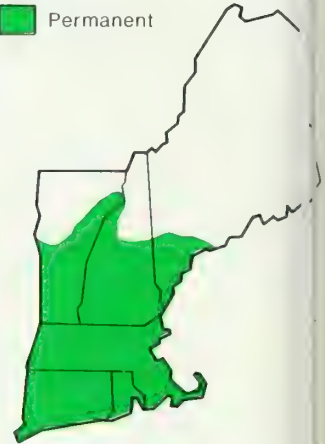
(*Cardinalis cardinalis*)

A.O.U. No. 593.0



Range

 Permanent



RANGE: Breeding: Central New England, w. to South Dakota, s. to Florida and Texas. Winter: Same as above.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Connecticut, Rhode Island, Massachusetts) to uncommon (Maine).

HABITAT: Breeding: Forest edges, open woodlands (less common in deep forest unless thickets are present), groves, parks, suburban gardens, open swamps, residential areas, parks. Wintering: Same. Easily attracted to feeding stations with sunflower seeds.

SPECIAL HABITAT REQUIREMENTS: Heavy underbrush such as *Lonicera* spp. or *Cornus* spp.

NESTING: Egg dates: April 10 to September 9, New York (Bull 1974:548). Clutch size: 2 to 5, typically 3. Incubation period: 12 to 13 days. Nestling period: About 14 days. Broods per year: 2 or 3. Age at sexual maturity: 1 year. Nest height: 3 to 20 feet (0.9 to 6.1 m), typically less than 10 feet (3.0 m). Nest site: In dense shrubs, small deciduous or coniferous trees, tangles of vines, thickets, briars.

HOME RANGE: 0.51 to 2.32 ha (1.3 to 5.7 acres) (average 1.18 ha (2.9 acres)) in Tennessee, but 10.97 to 23.24 ha (27.1 to 57.4 acres) (average 18.81 ha (46.5 acres)) in Ontario (Dow 1969). 0.31 to 0.45 acres (0.1 to 0.2 ha) (average 0.37 acre (0.1 ha)) in swamp thicket in Illinois (Brewer 1955). Cardinals range no further than a few miles from their territory during their lifetime (Laskey 1944).

SAMPLE DENSITIES: 30 males per 100 acres (40 ha) in oaks and hickory forests with clearings and hedgerows in Tennessee. 0.48 males per 100 acres (40 ha) in beech-maple woodlots in Ontario (Dow 1969). 23 territorial males per 100 acres (40 ha) in semi-open floodplain forest. 5 territorial males per 100 acres (40 ha) in field and edge (Stewart and Robbins 1958:333).

FORAGING: Major foods: Seeds and fruits, waste grain and insects. Substrate: Ground. Technique: Ground gleaning.

COMMENTS: Possibly life-long monogamy.

KEY REFERENCES: Bent 1968, Dow 1969, Laskey 1944.


Rose-breasted Grosbeak

(*Heucticus ludovicianus*)

O.U. No. 595.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. to Manitoba, s. to c. New Jersey, Georgia (mountains) and the lower Midwest. Winter: Mexico to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Edges of moist deciduous second-growth woods, wooded borders of swamps and streams, thickets, suburban trees, old orchards.

SPECIAL HABITAT REQUIREMENTS: An edge. Ideal habitat is the interface of tall forest trees and fields with dense shrubs and tangles (Pough 1949:217).

REPRODUCTION: Egg dates: May 6 to July 19, New York (Bull 197:549). Clutch size: 3 to 6, typically 4. Incubation period: 12 to 14 days. Nestling period: 9 to 12 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 6 to 26 feet (1.8 to 7.9 m). Typically 10 to 12 feet (3.0 to 4.6 m). Nest site: Usually built in the fork of a deciduous tree. Less commonly placed in a deciduous or evergreen shrub.

FOODING: Major foods: Insects and spiders (about 50 percent); the balance of diet is seeds, fruits. Substrates: Ground, tree canopy. Techniques: Ground, twig, leaf gleaning.

KEY REFERENCES: Bent 1968, Gabrielson 1915.


Indigo Bunting

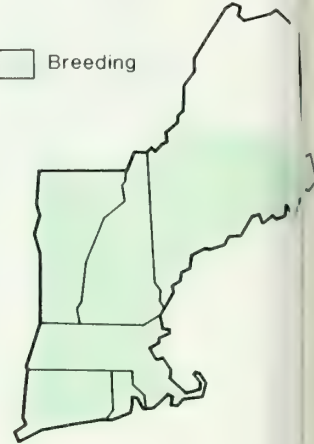
(*Passerina cyanea*)

A.O.U. No. 598.0



Range

 Breeding



RANGE: Breeding: New Brunswick, w. to North Dakota, s. to Georgia and Texas. Winter: Mexico and Central America. (Casually n. along coast to Massachusetts.)

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Edges of woods, old burns, open brushy fields, roadside thickets, brushy ravines. Tends to be numerous along creeks and rivers. Avoids deep woods.

SPECIAL HABITAT REQUIREMENTS: Brushy vegetation, elevated perches.

NESTING: Egg dates: May 26 to August 3, New York (Bull 1974:551). Clutch size: 2 to 6, typically 3 or 4. Incubation period: 12 to 13 days. Nestling period: 10 to 13 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest Height: 2 to 12 feet (0.6 to 3.7 m), typically 3 feet (0.9 m). Nest site: In dense cover, usually in weeds or in fork of shrub, low tree, or in brambles.

TERRITORY SIZE: 2.7 acres (1.1 ha) in sapling, shrub and vine habitat in Kansas (Fitch 1958). Average 0.26 acre (0.1 ha) in swamp-thicket in Illinois (Brewer 1955).

SAMPLE DENSITIES: 5 nests per 7.08 acres (2.9 ha) in thickets (Beecher 1942). 9 to 18 pairs per mile (1.6 km) In forest edge (Johnston 1947). 13 pairs per 25 acres (10.1 ha) in apple orchard (Stewart and Robbins 1958:337).

FORAGING: Major foods: Insects, weed seeds. Substrates: Branches, leaf surfaces, bare soil. Techniques: Ground, twig gleaning. Preferred feeding habits: Cornfields in late summer.

COMMENTS: Forest clearings created by logging and burning have been used extensively by the birds in the Northeast and have led to range expansion. The feeding habits are not well known. Summer diet is mainly insects and winter is mainly seed.

KEY REFERENCES: Allen 1933b, Bent 1968, Bradley 1944.

Rufous-sided Towhee

Pipilo erythrophthalmus

O.U. No. 587.0



Range

- Permanent
- Breeding



RANGE: Breeding: Central Maine, w. to se. Saskatchewan, s. to Florida, n. Louisiana and Oklahoma. Winter: Southern New England, w. to s. British Columbia, s. to Florida, Mexico, and s. California. Absent from mountains.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in breeding season. Uncommon in winter (Connecticut coast).

HABITAT: Breeding: Woodland edges and dry open interiors and clearings, hedgerows, roadside thickets, rocky hillsides and pastures. Wintering: Similar to breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Dense brushy cover (Pugh 1949:239).

REPRODUCTION: Egg dates: May 15 to August 4, New York (Bull 197:570). Clutch size: 3 to 6, typically 3 or 4. Incubation period: 12 to 13 days. Nestling period: 10 to 12 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: To 5 feet (1.5 m), typically on ground. Nest site: On or near ground in brushy cover or low in a shrub.

SAMPLE DENSITIES: 104 pairs per square mile (40 pairs/km²) in favorable habitat in North Dakota (Stewart and Karrud 1972). 50 territorial males per 100 acres (40 ha) in dry deciduous scrub; 33 territorial males per 100 acres (40 ha) in open slash area; 32 territorial males per 100

acres (40 ha) in young second-growth (following cutting); 6 territorial males per 100 acres (40 ha) in young second-growth (following cutting); 6 territorial males per 100 acres (40 ha) in pine-oak forest (Stewart and Robbins 1958:348).

FORAGING: Major foods: Insects, seeds, fruits, mast. Substrate: Leaf litter of forest floor. Techniques: Scratching, gleaning, scattering leaves with beak.

COMMENTS: McAtee (1926 in Bent 1968:570) found that 30 percent of the diet is animal matter and 70 percent vegetable matter.

KEY REFERENCES: Bent 1968, Davis 1960.

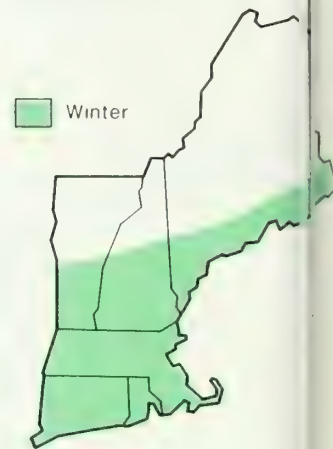
American Tree Sparrow

(*Spizella arborea*)

A.O.U. No. 559.0



Range



RANGE: Breeding: Quebec, w. to Alaska, s. to Newfoundland, n. Manitoba and n. British Columbia. Winter: Maritime Provinces, w. to s. British Columbia, s. to South Carolina, New Mexico and n. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Wintering: Open country, brushy edges of fields, weedy pastures, marshes, hedgerows, farmland.

FORAGING: Major foods: Winter—grass and weed seeds. Substrates: Leaf litter, grasses, and weeds. Techniques: Ground gleaning. Preferred feeding habitat: See wintering habitat.

COMMENTS: Individuals may wander several miles from winter range in search of food (Sargent 1959).

KEY REFERENCES: Bent 1968, Heydweiller 1935.

Chipping Sparrow

Spizella passerina)

C.O.U. No. 560.0



Range



RANGE: Breeding: Nova Scotia, w. to the Yukon, s. to Georgia and Central America. Winter: Southern Maryland, w. to Texas and s. California, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Suburban residential areas, farms, orchards, open mixed woodlands, clearings in forests and woodland edges, borders of lakes and streams.

REPRODUCTION: Egg dates: May 2 to July 19, New York (Bull 1944:583). Clutch size: 2 to 5, typically 3 or 4. Incubation period: 11 to 14 days. Nestling period: 7 to 8 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest height: 1 to 25 feet (0.3 to 7.6 m). Typically 3 to 10 feet (0.9 to 3.0 m). Nest site: In a tree, shrub or vine; rarely on ground. Nest is often low in ornamental evergreen, typically well concealed.

TERRITORY SIZE: 1 to 1.5 acres (0.4 to 0.6 ha) in residential areas in Michigan (Walkinshaw 1944). Two-thirds of an acre (0.3 ha) in Michigan (Sutton 1960). 7.6 acres (3.1 ha) in South Carolina (Odum and Kuenzler 1955).

SAMPLE DENSITIES: Maryland—90 territorial males per 100 acres (40 ha) in suburban residential area with orchard and lawn. 48 territorial males per 100 acres (40 ha) in unsprayed apple orchard. 18 territorial males per 100 acres (40 ha) in mixed agricultural habitats, including hedgerows and wood margins (Stewart and Robbins 1983:363).

FORAGING: Major foods: Insects, seeds. March through November diet: 38 percent animal, 62 percent vegetable (Judd 1900 in Bent 1968:1175). Substrates: Weeds, grasses. Technique: Ground gleaning. Preferred feeding habitat: Areas with abundant weeds.

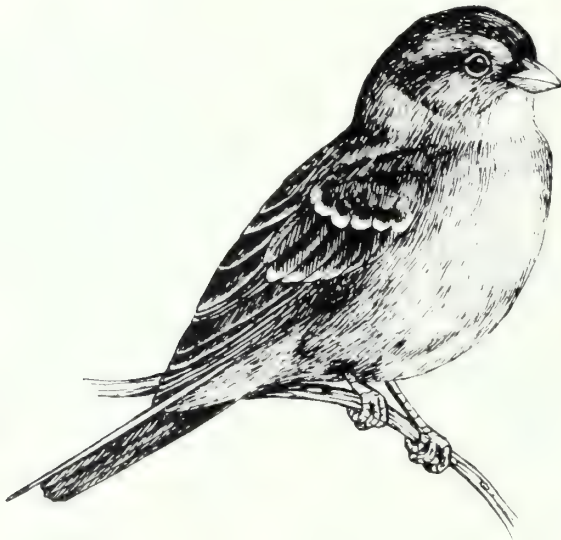
COMMENTS: Walkinshaw (1944) found that nest heights increased as breeding season progressed. Clearings in the forest caused by logging, fire, and so on, have increased Chipping Sparrow breeding habitat.

KEY REFERENCES: Bent 1968, Forbush 1929, Walkinshaw 1944.



Field Sparrow

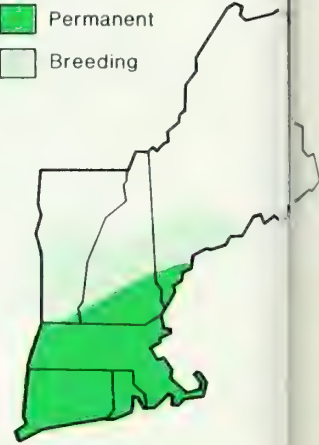
(*Spizella pusilla*)

A.O.U. No. 563.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Nova Scotia, w. to Montana, s. to South Carolina, Alabama and Texas. Winter: Southern New England, w. to Missouri, s. to Florida and Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Massachusetts) to uncommon (Maine).

HABITAT: Breeding: Old fields with scattered woody vegetation, also uses abandoned hayfields, briar thickets, and woodland edges.

SPECIAL HABITAT REQUIREMENTS: Open areas with low shrubs or trees.

NESTING: Egg dates: May 16 to August 17 (second brood), New York (Bull 1974:586). Clutch size: 2 to 5, typically 3 or 4. Incubation period: About 11 days. Nestling period: 7 to 10 days. Broods per year: 2 or 3. Age at sexual maturity: 1 year. Nest height: To 4 feet (1.2 m), typically on ground. Nest site: Early nests are usually on or near the ground in a tuft of grass. Later nests may be up to 4 feet high (1.2 m) in shrubs or trees.

TERRITORY SIZE: 0.31 to 1.62 ha (0.8 to 4 acres) in shrub-grassland habitat in Illinois (Best 1977). 0.75 to 2.0 acres (0.3 to 0.8 ha) (average 1.3 acres (0.5 ha)) on semi-wooded hillsides or idle prairie grass pasture in Iowa (Crooks and Hendrickson 1953). Less than 2 acres to 5 or 6 (0.8 to 2 or 2.4 ha) in various habitats (Bent 1968:1220).

SAMPLE DENSITIES: 8 pairs per 10 acres (4 ha) in fallow field in Michigan (Berger in Bent 1968). 1 pair per 3

acres (1.2 ha) in suitable habitat in Michigan (Wainshaw 1939b). 80 males per 100 acres (40 ha) of unimproved apple orchard (Stewart and Robbins 1958:364).

FORAGING: Major foods: Insects (over 40 percent in summer), seeds of weeds and grasses. Substrate: Ground. Technique: Ground gleaning.

COMMENTS: The diet consists of about 41 percent animal matter and 59 percent vegetable matter (Judd 1937 in Bent 1968:1228).

KEY REFERENCES: Bent 1968, Best 1977, 1978, Crooks 1948.

Vesper Sparrow

(*Pooecetes gramineus*)

A.O.U. No. 540.0



Range

- Permanent
- Breeding
- Winter



RANGE: Breeding: Nova Scotia, w. to s. British Columbia, s. to North Carolina, Texas and c. California. Winter: Southern New England s. to Florida, The Gulf States and Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Aine).

HABITAT: Breeding: Short-grass meadows, pastures, hayfields, cultivated grain fields, dry open uplands, burned and cut-over areas in forests, country roadsides. Wiens (1969:41) found that birds favor sparsely vegetated uplands and may use areas with widely scattered shrubs.

SOCIAL HABITAT REQUIREMENTS: Open areas with short herbaceous vegetation, conspicuous singing perches.

REPRODUCTION: Egg dates: May 5 to August 16, New York (Bull 194:581). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 12 to 13 days. Nestling period: 9 to 14 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest site: In or at base of grass tussock in depression in ground. Early nests may be completely exposed from above until concealed by surrounding growing vegetation.

TERRITORY SIZE: 1.2 to 1.8 acres (0.5 to 0.7 ha) per pair in uncultivated field in Michigan (Bent 1968:869). 1.5 to 2.7 acres (0.6 to 1.1 ha) (average 2.2 acres (0.9 ha)) for 5

territories in Wisconsin grasslands (Wiens 1969:35).

HOME RANGE: Home ranges are typically larger than those of other grassland sparrows (Bent 1968:869).

SAMPLE DENSITIES: 3 pairs per 10 acres (4 ha) in a fallow field bordered by woods in Michigan (Bent 1968:869). Range of 8 to 12 pairs annually in a 14-acre (5.7 ha) uncultivated field in Michigan (Bent 1968:869). 40 pairs per square mile (15 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 5 males per 80 acres (32.4 ha) in grassland in Wisconsin (Wiens 1969:53).

FORAGING: Major foods: Insects and other small invertebrates (33 percent), weed seeds (66 percent) (Bent 1968:875). Substrates: Grasses and weeds, sparsely vegetated ground. Technique: Ground gleaning.

KEY REFERENCES: Bent 1968, Bryant 1931, Wiens 1969.

Savannah Sparrow

(*Passerculus sandwichensis*)

A.O.U. No. 542.0



Range

- Permanent
- Breeding



RANGE: Breeding: Northern Labrador, w. to n. Alaska, s. to New Jersey, n. New Mexico and s. California. Winter: Massachusetts (Cape Cod), w. to Colorado and s. Alaska, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Grassy swales, hayfields, meadows, salt marshes. Habitat varies greatly in vegetation, moisture, and so on, but nest location and construction are consistently similar. Birds may favor moist lowland habitat with dense ground vegetation (Wiens 1969:41).

SPECIAL HABITAT REQUIREMENTS: Grasses and other vegetation of moderate height—neither short nor tall.

NESTING: Egg dates: May 11 to July 16, New York (Bull 1974:572). Clutch size: 3 to 6, typically 4 to 5. Incubation period: 10 days (Welsh 1975). Nestling period: 8 to 11 days. Average 9.4 days (Welsh 1975). Broods per year: 2. Age at sexual maturity: 1 year. Nest site: In hollow on ground, typically hidden by a canopy of surrounding vegetation, often in grass tufts. Colonial nesting has been reported but is infrequent.

TERRITORY SIZE: 0.16 to 1.09 ha (0.4 to 2.7 acres), (average 1.4 acre (0.57 ha)) for 16 territories in grasslands (Wiens 1973). 0.4 to 4.3 acres (0.2 to 1.7 ha) (average 1.7 acres (0.7 ha)) for 91 territories in grasslands in Wisconsin (Wiens 1969:35). 99 territories ranged from 0.21 to 1.91 ha (0.5 to 4.7 acres) in Nova Scotia (Stobo and McLaren 1975:32).

HOME RANGE: 0.2 to 0.8 acre (0.8 to 0.32 ha) (average 0.4 acre (0.17 ha)) in dune habitat in Nova Scotia (Welsh 1975).

SAMPLE DENSITIES: 115.9 pairs per km² (301 pairs/square mile) in grassland in Wisconsin (Wiens 1973). 37 territorial males per 80 acres (32.4 ha) in grasslands in Wisconsin (Wiens 1969:53). 120 pairs per square mile (46 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 50 territorial males per 100 acres (12.5/ha) in lightly grazed pasture in Maryland (Stewart and Robbins 1958:351).

FORAGING: Major foods: Insects, especially beetles and grasshoppers, seeds of grasses and weeds. Subordinate foods: Grasses and weeds. Technique: Herb gleaning.

KEY REFERENCES: Bent 1968, Dixon 1978, Stobo and McLaren 1975, Welsh 1975, Wiens 1969, 1973.


Grasshopper Sparrow

(*Ammodramus savannarum*)

O.U. No. 546.0



Range

 Breeding



RANGE: Breeding: Southern New Hampshire, w. to British Columbia, s. to Florida, West Indies, and Central America. Winter: North Carolina, w. to c. California, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (Massachusetts) to rare and local (Vermont).

HABITAT: Breeding: Hayfields, weedy fallow fields, prairies. Avoids shrubby fields. Johnston and Odum (1956) reported that grasshopper sparrows were absent from fields with greater than 35 percent shrub cover. Birds frequent uplands with ground vegetation of various densities (Wiens 1969:41).

SOCIAL HABITAT REQUIREMENTS: Continuous tall herbaceous cover. Conspicuous perches for singing.

REPRODUCTION: Egg dates: May 27 to August 6, New York (Bull 194:580). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 12 to 13 days. Nestling period: 9 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest site: In a depression on the ground, usually well hidden by surrounding weeds and grasses. Prefers orchard grass, alfalfa, and clover. Birds are solitary or nest in small colonies.

TERRITORY SIZE: 6 territories averaged 3.4 acres (1.4 ha) in Iowa prairie (Kendeigh 1941 a). 0.32 to 1.34 ha (0.8 to 3.3 acres) (average 0.73 ha (1.8 acres)) for 16 territories in grasslands (Wiens 1973). 0.8 to 4.3 acres (0.3 to 1.7

ha) (average 2.1 acres (0.8 ha)) in grasslands in Wisconsin (Wiens 1969:35). 1.2 to 3.3 acres (0.5 to 1.3 ha) (average 2.0 acres (0.8 ha)) for 22 territories on a farm in West Virginia (Smith 1963).

SAMPLE DENSITIES: 92 pairs per km² (239 pairs/square mile) on grassland in Wisconsin (Wiens 1973). 30 territorial males per 80 acres (32.4 ha) in grasslands in Wisconsin (Wiens 1969:53). 60 pairs per square mile (23 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 77 territorial males per 100 acres (40 ha) in weedy fallow field in Maryland. 32 territorial males per 100 acres (40 ha) in weedy pasture in Maryland (Stewart and Robbins 1958:352).

FORAGING: Major foods: Insects, weed and grass seed. Substrates: Annual weeds and grasses, ground. Technique: Ground gleaning.

COMMENTS: Despite the availability of suitable habitat, grasshopper sparrow abundance fluctuates from year to year—reasons unknown. Judd (1901 in Bent 1968:735) found that the February to October diet contained 63 percent animal matter and 37 percent vegetable matter.

KEY REFERENCES: Bent 1968, Kendeigh 1941a, Smith 1963, Wiens 1969, 1973.


Henslow's Sparrow

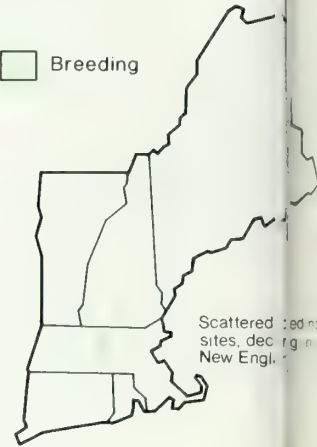
(*Ammodramus henslowii*)

A.O.U. No. 547.0



Range

 Breeding



RANGE: Breeding: Western New York, w. to South Dakota, s. to North Carolina and Texas. Winter: South Carolina, s. to Florida and w. along the Gulf Coast to Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare, local.

HABITAT: Breeding: Neglected weedy fields—commonly of broomsedge—wet meadows, saltmarsh edges. Occasionally in dry and cultivated uplands. Wiens (1969:41) observed birds in areas with dense ground vegetation. May favor moist lowland habitat and may use areas with widely scattered shrubs.

SPECIAL HABITAT REQUIREMENTS: Dense herbaceous vegetation, moderate amounts of moisture, ground litter, singing perches (Robins 1971).

NESTING: Egg dates: May 17 to July 5, New York (Bull 1974:579). Clutch size: 3 to 5, typically 4. Incubation period: about 11 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest site: Solitary or loosely colonial. Nest is usually in a depression on the ground beside or atop a grass tussock and well hidden by the surrounding vegetation.

TERRITORY SIZE: 36 territories averaged 0.8 acres (0.3 ha) in hayfield in Michigan (Robins 1971). 8 territories averaged 1.5 acres (range 0.7 to 2.7 acres) (average 0.6 ha, range 0.3 to 1.1 ha) in grasslands in Wisconsin (Wiens 1969:35).

SAMPLE DENSITIES: 50 males per 100 acres (40 ha) of hayfield in Michigan (Robins 1971). 12 pairs per 10 acres (4

ha) of dense grass in Pennsylvania (Sutton 1928). 4 territorial males per 80 acres (32.4 ha) in grasslands in Wisconsin (Wiens 1969:53). 15 territorial males per 100 acres (40 ha) in abandoned broomsedge field in Maryland (Stewart and Robbins 1958: 353).

FORAGING: Major foods: Insects, seeds of grasses and weeds. Substrates: Ground litter, weed stalks. Technique: Ground gleaning.

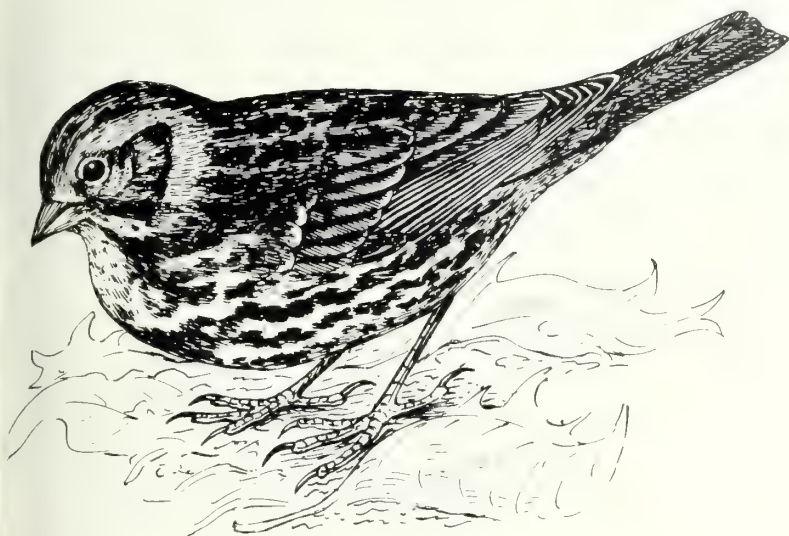
COMMENTS: Hyde (1939) found that the April to October diet consisted of 82 percent animal matter and 18 percent vegetable matter.

KEY REFERENCES: Bent 1968, Hyde 1939, Robins 1971, Wiens 1969.

Fox Sparrow

(*Passerella iliaca*)

A.O.U. No. 585.0



Range

Winter



RANGE: Breeding: Northern Quebec, w. to Alaska, s. to Quebec, Colorado and s. California. Winter: Coastal Massachusetts, s. to Florida, Pennsylvania, w. to British Columbia, s. to New Mexico and the Gulf States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Wintering: Dense woodland thickets, brushy edges where field meets forest.

FEEDING: Major foods: Insects, weed seeds, fruits. Substrates: Leaf litter. Techniques: Scratching, ground pecking.

COMMENTS: Foods taken in all months of the year excluding June, July, and August consisted of 14 percent animal and 86 percent vegetable matter (Judd 1901 in Bent 1968:1404).

KEY REFERENCE: Bent 1968.

Song Sparrow

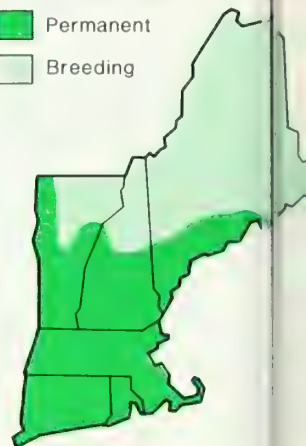
(*Melospiza melodia*)

A.O.U. No. 581.0



Range

- Permanent
- Breeding



RANGE: Breeding: Nova Scotia, w. to s. Alaska, w. to coast to North Carolina and mountains of n. Georgia. Also to Missouri and Mexico. Winter: New Brunswick, w. to Wisconsin and British Columbia, s. to Florida and the Gulf States.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Brushy fields, swamps, forest edges, roadsides, hedgerows, farms, suburbs, cities, shores of ponds and streams. Tolerates a wide range of habitat conditions. Wintering: Similar to breeding habitat.

SPECIAL HABITAT REQUIREMENTS: Songposts (elevated perches).

NESTING: Egg dates: April 17 to August 11, New York (Bull 1974:600). Clutch size: 3 to 6, typically 3 to 5. Incubation period: 12 to 13 days. Nestling period: 10 to 14 days. Broods per year: 2 or 3. Age at sexual maturity: 1 year. Nest height: To 12 feet (3.7 m), typically 0 to 4 feet (0 to 1.2 m). Nest site: Early nests are usually on ground and are typically well hidden in grasses or weeds or concealed under a bush or brush pile. Subsequent nests may be on ground or elevated in a shrub. May raise height of successive nests with the growth of herbaceous vegetation. *Rosa multiflora* and *Rubus* spp. are preferred nest site vegetation (DeGraaf et al. 1975).

TERRITORY SIZE: Ranges from 0.5 to 1.5 acres (0.2 to 0.6 ha) in favorable habitat (Nice 1937:74). From 167 to 822 m² (0.1 to 0.6 acres) on an island off British Columbia (Tomba 1962).

HOME RANGE: Resident birds in winter may range over an area 6 to 10 times as large as territory (Nice 1937:763).

SAMPLE DENSITIES: Maryland—21 territorial males per 19.2 acres (7.8 ha) in shrubby field. 3 territorial males per 9.5 acres (3.8 ha) in open hemlock-spruce forest. 4 territorial males per 20.5 acres (8.3 ha) in infrequently mowed apple orchard (Stewart and Robbins 1958).

FORAGING: Major foods: Insects, weed seeds, fruits. Substrates: Grasses, stems and twigs of bushes. Techniques: Ground, herb and twig gleaning.

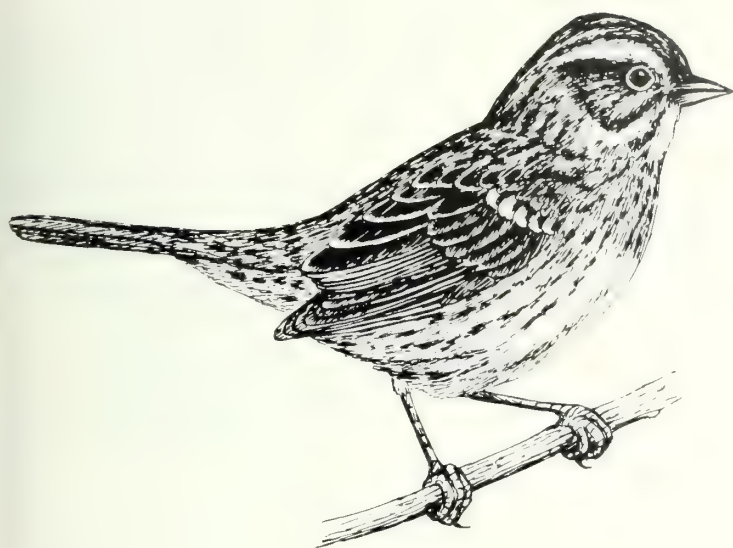
COMMENTS: Prefers wet lowland situations with low, regular plant growth and abundant sunlight. Birds have been found nesting in small woodland openings with a few rods in diameter in New York (Eaton 1914).

KEY REFERENCES: Bent 1968, Nice 1937, 1943.


Lincoln's Sparrow

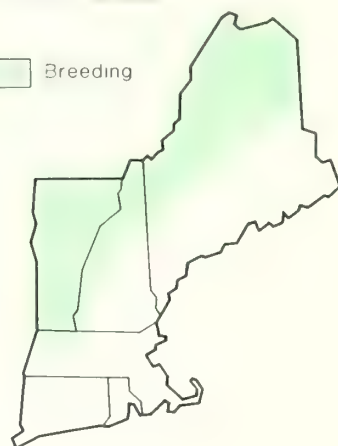
(*Melospiza lincolni*)

A.O.U. No. 583.0



Range

 Breeding



RANGE: Breeding: Quebec, w. to Alaska, s. to n. New England, n. Minnesota, New Mexico and s. California.

Winter: Southwestern United States, s. to Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Thickets of alder and willow along bays, lakes, and streams. Natural brushy openings and clearings created by fire or cutting, dry rocky hillsides with low shrub growth.

SPECIAL HABITAT REQUIREMENTS: Needs low brushy growth 4 to 8 feet (1.2 to 2.4 m) high with openings of grasses or sedges (Bent 1968).

REPRODUCTION: Egg dates: June 10 to June 28, New York (Bull 1974:599). Clutch size: 3 to 6, typically 4 or 5. Incubation period: About 13 days. Nestling period: About 14 to 16 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: Often on tussock of grass or sedge or in mosses and lichens. Usually well hidden by surrounding vegetation.

TERRITORY SIZE: About 1 acre (0.4 ha) in forest edge habitat in Ontario (Bent 1968:1440).

FEEDING: Major foods: Insects (more than 60 percent in summer); weed seeds, grain. Substrate: Leaf litter. Technique: Ground gleaning.

COMMENTS: 31 birds taken in Massachusetts and New York in February, April, May, September, and October had consumed 42 percent animal and 58 percent vegetable material (Judd 1901 in Bent 1968:1451).

KEY REFERENCES: Bent 1968, Brewster 1936.



Swamp Sparrow

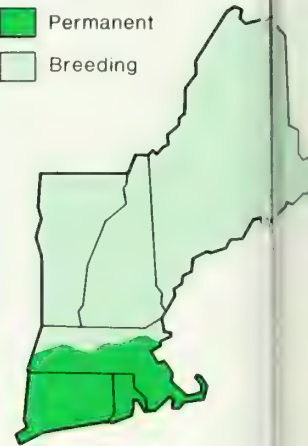
(*Melospiza georgiana*)

A.O.U. No. 584.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland, w. to c. Canada, s. to New Jersey and Maryland, n. Illinois and Nebraska. Winter: Southern New England, s. to Florida, the Gulf States, and Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Marshes, swamps, bogs, sloughs with bushes, rank grasses, sedges or reeds, low swampy shores of lakes and streambanks. Usually near fresh water. Avoids heavily wooded wetlands.

NESTING: Egg dates: May 15 to July 22, New York (Bull 1974:599). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 12 to 15 days. Nestling period: 9 to 13 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest site: Often directly above water, on bent down grasses among cattails, or in a low bush. Frequently builds over water 0.5 to 2 feet (0.2 to 0.6 m) deep or more. Sutton (1960) found that birds preferred to nest in mixed vegetation (cattail, spirea, sedge, dwarf birch, and tamarack saplings) rather than in pure cattails.

SAMPLE DENSITIES: 21 birds per 100 acres (40 ha) in open hemlock-spruce bog in Maryland (Robbins 1949 in Bent 1968).

FORAGING: Major foods: Insects (more than 80 percent in spring and early summer), weed seeds (90 percent in late summer and fall). Substrates: Shallow water, marsh vegetation. Techniques: Wading, gleaning.

COMMENTS: Birds are highly insectivorous in spring and early summer (88 percent of diet), becoming almost entirely granivorous in late summer and fall (84 to 100 percent) (Martin et al. 1951).

KEY REFERENCE: Bent 1968.

White-throated Sparrow

(*Zonotrichia albicollis*)

O.U. No. 558.0



Range

- Permanent
- Breeding
- Winter



RANGE: Breeding: Newfoundland, w. to n. Mackenzie, s. to n. New England, Massachusetts (Berkshires), New York (Catskills), Pennsylvania (Poconos), Wisconsin, and Alberta. Rarely to West Virginia. Winter: Central New England, s. to Florida, Pennsylvania, and Missouri, to the Gulf Coast and Mexico. Rarely to s. Canada.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (Connecticut).

HABITAT: Breeding: Edges of northern deciduous and coniferous forests, brushy clearings, open stunted tree growth of higher elevations, border of bogs, cut-over and open second-growth woodlands.

REPRODUCTION: Egg dates: May 30 to July 21, New York (Bull 1944:595). Clutch size: 3 to 5, typically 4. Incubation period: 11 to 14 days. Nestling period: 12 to 14 days. Broods per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: To 3 feet (0.9 m), typically on ground. Nest site: On or close to ground, in brush pile, under fallen limbs, in grass hummock or mat of dead grasses or broken fern. Typically located at edge of a clearing and well concealed by ground vegetation.

TERRITORY SIZE: 110 territories ranged in size from 0.5 to 2.3 acres (0.2 to 1.1 ha), (average 0.52 acres 0.3 ha) in Algonquin Provincial Park in Ontario (Martin 1960).

SAMPLE DENSITIES: Martin (1960) found densities varied from no birds in bog and hardwood forest to 56 territorial males per 100 acres (40 ha) in balsam fir and white spruce.

FORAGING: Major foods: Insects, seeds of grasses and weeds, wild fruits. Substrates: Weeds and grasses, leaf litter. Technique: Ground gleaning.

COMMENTS: Judd's (1901) analysis of the contents of 217 stomachs collected in all months except June revealed a diet of 19 percent animal and 81 percent vegetable matter (Bent 1968:1375).

KEY REFERENCES: Bent 1968, Fischer and Gills 1946, Martin 1960.




Dark-eyed Junco

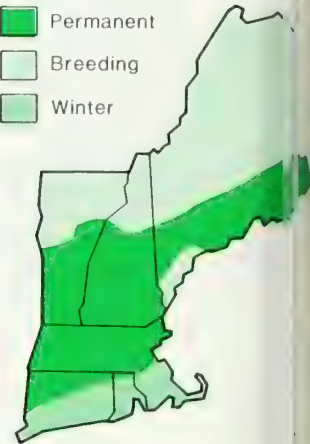
(*Junco hyemalis*)

A.O.U. No. 567.0



Range

-  Permanent
-  Breeding
-  Winter



RANGE: Breeding: Quebec, w. to Alaska, s. to c. New England, Georgia (mountains), n. Minnesota and s. Yukon. In the West, s. to the mountains of sw. United States. Winter: Throughout most of the United States except the Florida peninsula and the extreme northern parts of breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Breeding: Coniferous and mixed forests, forest edges, (Johnston 1970) borders of streams, woodland clearings, sides of logging roads. Wintering: Areas with conifers for night roosting. Fretwell (1968) found that Juncos preferred open weedy fields and used mature deciduous and coniferous woods infrequently. Hedgerows and brushy field borders.

NESTING: Egg dates: April 28 to August 15, New York (Bull 1974:588). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 12 to 13 days. Nestling period: 9 to 12 days. Broods per year: 2. Age at sexual maturity: 1 year. Nest site: Often on ground under weeds and grasses, on slope, under fallen log or at base of tree or roadbank in cavity formed by roads. Occasionally nests low in shrub or tree.

HOME RANGE: 27, 33, and 17 ha (66.7, 81.5, 42 acres) for 2 flocks (one flock used 2 home ranges) (Gottfried and Franks 1975).

FORAGING: Major foods: Insects, wild fruits, weed seeds. Substrates: Grasses, leaf litter, weeds. Technique:

Ground gleaning. Preferred feeding habitat: Weedy patches, hedgerows.

COMMENTS: Juncos feed on the ground in all seasons except when deep snow forces them to search in shrubs and forbs. Formerly Slate-colored Junco.

KEY REFERENCES: Bent 1968, Forbush 1929, Fretwell 1969.

Lapland Longspur

(*Calcarius lapponicus*)

O.U. No. 536.0



Range



RANGE: Breeding: North of the tree line in Canada and Alaska. Winter: Winters s. to New Jersey, Colorado, and California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Wintering: Cultivated fields, open weedy meadows, beaches, sandy waste places with sparse vegetation.

FEEDING: Major foods: Seeds of weeds and grasses. Substrates: Short grasses, bare earth. Techniques: Ground gleaning. Preferred feeding habitat: Stubble fields, coastal sandy areas where vegetation is sparse.

REFERENCE: Bent 1968.

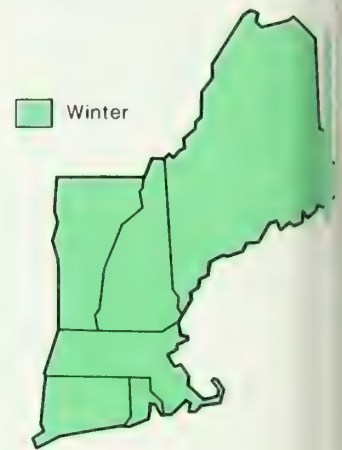
Snow Bunting

(*Plectrophenax nivalis*)

A.O.U. No. 534.0



Range



RANGE: Breeding: Arctic regions of North America, s. to n. Quebec, c. Alaska. Winter: Central Quebec, w. to s. Alaska, s. to Virginia (coast), Pennsylvania, and Oregon.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Wintering: Lake shores, salt marshes, open beaches, cultivated fields and windswept grasslands.

FORAGING: Major foods: Seeds of grasses, weeds, trees, especially alders and birches. Substrates: Surface of snow, tips of weeds and grasses. Technique: Ground gleaning. Preferred feeding habitat: Fields, farmyards, manure piles, ponds, beaches, frozen marshes, and meadows.

KEY REFERENCES: Bent 1968, Forbush 1929.

Bobolink

(*Polichonyx oryzivorus*)

O.U. No. 494.0



Range

 Breeding



RANGE: Breeding: Nova Scotia w. to British Columbia, s. Pennsylvania and the coast of s. New Jersey (rarely), Indiana, Colorado, and nc. California. Winter: South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common to uncommon.

HABITAT: Breeding: Hayfields, meadows, marshes, fallow fields. May prefer moist lowlands to uplands.

SPECIAL HABITAT REQUIREMENTS: Large expanses of grassland or forb cover.

REPRODUCTION: Egg dates: May 18 to June 20, New York (Bull 194:523). Clutch size: 4 to 7, typically 5 or 6. Incubation period: 13 days. Nestling period: 10 to 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: In dense vegetation, often hay, alfalfa, clover, or weeds usually in a slight hollow in ground. Occasionally nests reconstructed above ground in weed stalks.

TERRITORY SIZE: 22 territories ranged from 2.7 to 12.1 acres (1.1 to 4.9 ha) (average 6.3 acres (2.6 ha)) in grasslands in Wisconsin (Wiens 1969:35).

SAMPLE DENSITIES: 9 territorial males per 80 acres (32.4 ha) in grasslands in Wisconsin (Wiens 1969:53). 100 pairs per square mile (39 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FEEDING: Major foods: Insects, weed and grass seeds; in New England, the summer diet consists of 70 to 90 per-

cent insects that are replaced almost entirely by grain (90 percent) in September (Forbush 1929 V. 2:404). Substrates: Grasses, weeds. Techniques: Ground and herb gleaning. Preferred feeding habitat: Cultivated grain fields.

COMMENTS: Changes in haying practices (earlier cuttings) and the loss of agricultural land to development have contributed to the Bobolink's decline in the Northeast. Wiens (1969:41) found that Bobolinks in Wisconsin favored large open fields with dense ground vegetation.

KEY REFERENCES: Bent 1958, Forbush 1929, Wiens 1969.


Red-winged Blackbird

(*Agelaius phoeniceus*)

A.O.U. No. 498.0



Range

 Breeding



RANGE: Breeding: Nova Scotia w. to Alaska, s. to Florida and Mexico. Winter: New Jersey, e. Pennsylvania, Ohio, w. to British Columbia, s. to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Marshes, swamps, wet meadows, ponds, dry fields. Prefers wetlands with extensive growth of cattails, bulrushes, sedges, and reeds.

SPECIAL HABITAT REQUIREMENTS: Sites for night roosting close to food supply (Bird and Smith 1964).

NESTING: Egg dates: April 26 to July 9, New York (Bull 1974:526). Clutch size: 3 to 5, typically 3 or 4. Incubation period: 10 to 12 days. Nestling period: 10 to 11 days. Broods per year: 2 or 3. Age at sexual maturity: 1 or 2 years. Females — 1 year, males — probably 2 years (Harrison 1975:214). Nest height: 3 inches to 14 feet (7.6 cm to 4.3 m). Typically less than 6 feet (1.8 m). Nest site: In almost any kind of low herbaceous vegetation, shrub, or low tree. Usually near or above water but may be placed in dry sites.

TERRITORY SIZE: Average sizes ranged from 200 to 600 m² (0.05 to 0.15 acres) in bulrush with a little cattail in Washington (Holm 1973). Average size of 21 territories in cattail clumps surrounded by grassland was 2,512 square feet (233 m²). Average size of 22 territories in main area of cattail marsh including central and peripheral territories was 10,653 square feet (990 m²) (Orians 1961). 51 marsh territories averaged 0.17 acre (0.07 ha) (range 0.06 to 1.12 acres (0.02 to 0.5 ha)), upland territo-

ries averaged 0.54 acre (0.2 ha) (range 0.33 to 0.99 acres (0.07 to 0.4 ha)) (Case and Hewitt 1963).

SAMPLE DENSITIES: 16 pairs per 100 acres (40 ha) in marsh, 11 pairs per 100 acres (40 ha) in uplands (Case and Hewitt 1963). 164 pairs per square mile (63 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 73 territorial males per 100 acres (40 ha) in cattail marsh, 36 territorial males per 100 acres (40 ha) in shrubby field with stream-bordered trees (Stewart and Robbins 1958:322).

FORAGING: Major foods: Insects, weed seeds, grain. Substrates: Short grasses, freshly plowed earth. Technique: Ground gleaning. Preferred feeding habitats: Feeds up to 1 mile (1.6 km) from nest site in cropland, orchards, hayfields, and so on.

COMMENTS: The fall diet consists almost entirely of weed seeds.

KEY REFERENCES: Bent 1958, Case and Hewitt 1963, Orians 1961.

Western Meadowlark

(*Icterus magna*)

D.U. No. 501.0



Range

- Permanent
- Breeding



GE: Breeding: New Brunswick, w. to c. Ontario, s. to Florida and n. Mexico. Winter: Central New England and New York, s.

ATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

A TAT: Breeding: Open farmlands, especially pasture, hayfields and grassy meadows. They may use areas with widely scattered shrubs and may favor moist winds.

ECIAL HABITAT REQUIREMENTS: Grasslands, elevated singing perches.

ESNG: Egg dates: May 9 to August 4, New York (Bull 1975:524). Clutch size: 2 to 6, typically 3 to 5. Incubation period: 13 to 15 days. Nestling period: 10 to 12 days. Eggs per year: 2. Age at sexual maturity: 1 year. Nest site: On ground in a natural depression or one scraped by female, sometimes partially or entirely roofed by nest materials and adjacent vegetation. Prefers to nest in low, 10 to 20 inches (25 to 50 cm) high.

ERTORY SIZE: 3 to 15 acres (1.2 to 6.1 ha) in moist lowland in Wisconsin (Lanyon 1957). 18 territories ranged from 4.3 to 7.9 acres (1.7 to 3.2 ha) (average 5.8 acres (2.3 ha)) in grasslands in Wisconsin (Wiens 1969:35).

HOME RANGE: 2.8 acres (1.1 ha) in a field of brome grass in Kansas (Fitch 1958).

SAMPLE DENSITIES: 20.9 nests per 100 acres (40 ha) in pasture, 12.6 nests per 100 acres (40 ha) in hayfield in Illinois. Ungrazed pasture had more nests than grazed pasture (Roseberry and Klimstra 1970). 12 territorial males per 80 acres (32.4 ha) in grasslands in Wisconsin (Wiens 1969:53).

FORAGING: Major foods: Insects, especially beetles and grasshoppers, weed seeds, grass seeds, waste grain seed. Substrates: Grasses and weeds. Techniques: Grass and ground gleaning.

COMMENTS: Winter food consists almost entirely of weed and grass seeds and waste grains. Wiens (1969:41) found that meadowlarks in Wisconsin favored large open fields.

KEY REFERENCES: Bent 1958, Lanyon 1957, Roseberry and Klimstra 1970.

Rusty Blackbird

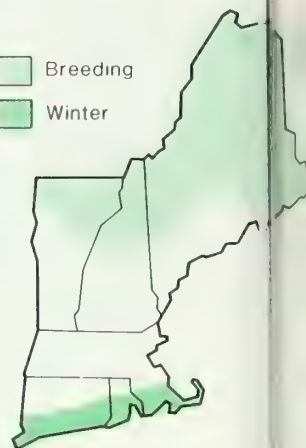
(*Euphagus carolinus*)

A.O.U. No. 509.0



Range

-  Breeding
-  Winter



RANGE: Breeding: Northern Quebec and s. Canadian Provinces, w. to Alaska, s. to n. New England and the Adirondack Mountains of New York. Winter: Southern New England, s. to Florida, Ohio River Valley, w. to Colorado, s. to Texas.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (northern Maine) to uncommon (northern Vermont) during breeding season. Rare and local (Connecticut, se. Massachusetts) in winter; more common southward.

HABITAT: Breeding: Wooded swamps, tree-bordered marshes, beaver ponds, muskegs, boreal bogs and stream borders with alder and willow thickets, wooded islands in lakes. Rarely seen in fields with other blackbirds. Wintering: Wooded swamps.

NESTING: Egg dates: May 7 to June 15, New York (Bull 1974:533). Clutch size: 4 to 5, typically 4 or 5. Incubation period: 14 days. Nestling period: About 13 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 2 to 20 feet (0.6 to 6.1 m), typically less than 10 feet (3.0 m). Nest site: Solitary nester. Nest is often in dense foliage of young conifers, especially balsam and spruce. Also builds in deciduous shrubs in marshes such as sweet gale and buttonbush.

TERRITORY SIZE: Breeding territories are sometimes large. Nests may be 0.5 mile (0.8 km) or more apart (Harrison 1975:217).

FORAGING: Major foods: Insects, seeds of weeds, wild fruits from the remainder. Technique: Ground gleaning. Preferred feeding habitat: Open areas, edges of northern ponds and streams.

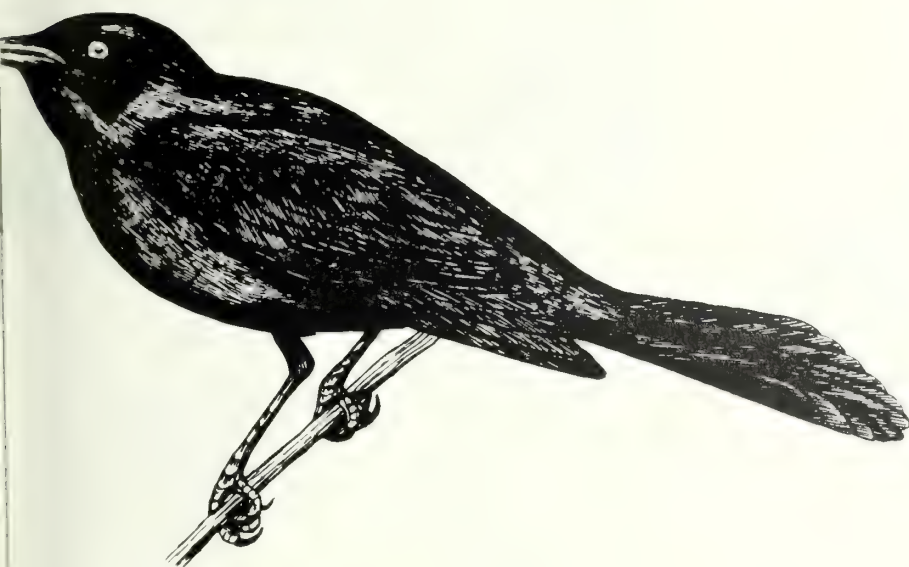
COMMENTS: The stomach contents of 132 birds taken all months of the year except June and July contained 41 percent animal and 47 percent vegetable matter (Bent 1958:288).

KEY REFERENCES: Bent 1958, Kennard 1920.

Common Grackle

(*Quiscalus quiscula*)

A.O.U. No. 511.0



Range

- Permanent
- Breeding



RANGE: Breeding: Newfoundland, w. to the s. Canadian Rockies, s. to Florida, the Gulf Coast and Texas. Winter: coastal sections of s. New England s. Ohio River Valley and Kansas, s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant in breeding season. Uncommon in winter.

HABITAT: Breeding: Farmlands, suburbs, marshes, camps, meadows at low elevations. Uncommon in mountains. Wintering: Agricultural areas with or without open water and with some bare ground.

NESTING: Egg dates: April 12 to June 4, New York (Bull 1974:536). Clutch size: 3 to 6, typically 5. Incubation period: 11 to 12 days. Nestling period: About 18 to 20 days. Broods per year: Probably 1. Nest height: 1 to 60 feet (0.3 to 18.3 m). Typically 10 to 20 feet (3.0 to 6.1 m). Nest site: Solitary or colonial nesters. Usually nests in small colonies of 20 to 30 pairs. Prefers conifers but uses deciduous trees and shrubs. Less frequently nests in caves, rock ledges, or cattails.

TERRITORY SIZE: Both male and female defend a small area surrounding nest (Ficken 1963).

HOME RANGE: Grackles range a mile or more from the nest site.

SAMPLE DENSITIES: 92 pairs per square mile (35 pairs/ha) in favorable habitat in North Dakota (Stewart and Yntud 1972).

FORAGING: Major foods: Ground-dwelling insects, fruits, mast, waste grains, small quantities of fish, crustaceans, amphibians, nesting birds and eggs. Substrates: Mud, cultivated earth, short grasses. Techniques: Ground gleaning, probing. Preferred feeding habitat: Open fields, shores of ponds, lawns.

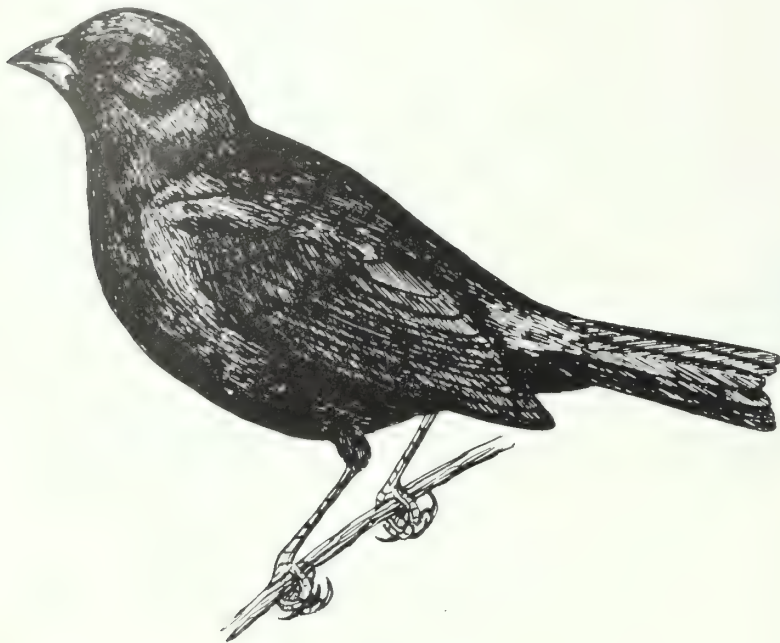
COMMENTS: Birds are highly gregarious in all seasons. Ornamental evergreens are commonly used for nesting. Maxwell and others (1976) found 24 percent of 2,601 nests located in redcedar. Records of Grackles using cavities and birdhouses indicates an ability to utilize marginal habitats.

KEY REFERENCES: Bent 1958, Maxwell and Putnam 1972, Peterson and Young 1950.

Brown-headed Cowbird

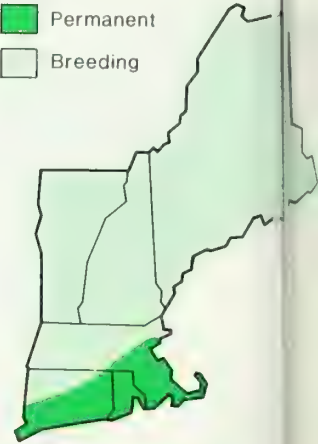
(*Molothrus ater*)

A.O.U. No. 495.0



Range

- Permanent
- Breeding



RANGE: Breeding: Nova Scotia, w. to British Columbia, s. to Virginia, Louisiana and Mexico. Winter: Coastal sections of Massachusetts, s. to c. Florida. Ohio River Valley, w. to n. California, s. to Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Open coniferous and deciduous woodlands, forest edges, agricultural land, suburban areas. Wintering: Agricultural lands, feeding stations.

NESTING: Egg dates: April 23 to July 31, New York (Bull 1974:539). Clutch size: 1 to 6, typically 3 (usually lays only one egg per nest). Broods per year: 3 or 4. Age at sexual maturity: 1 year. Nest height: To 80 feet (24.3 m). Nest site: Parasitic — builds no nest. Lays eggs in nests of other birds (214 species of which 121 have raised young cowbirds successfully). Song Sparrows and Yellow Warblers are most common hosts (Harrison 1975).

TERRITORY SIZE: Apparently does not defend an area but has a fixed breeding area in which female lays eggs (Friedmann 1929).

HOME RANGE: About 20 to 30 acres (8.1 to 12.1 ha) in floodplain habitat (open weedy fields with scattered trees) in Ohio (Nice 1937:154).

SAMPLE DENSITIES: 152 pairs per square mile (59 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FORAGING: Major foods: Seeds of weeds, grains, insects. Substrates: Short grasses, soft earth, weeds. Technique: Ground gleaning. Preferred feeding habitat: Grain fields, pastures where they often feed among cattle.

COMMENTS: The female lays an average of 10 to 12 eggs during the breeding season (range 1 to 15) (Payne 1965). Birds are often seen feeding in mixed flocks with wings or Common Grackles. Both sexes may flock all seasons.

KEY REFERENCES: Friedmann 1929, Nice 1937, Payne 1965.

Orchard Oriole

(*Icterus spurius*)

A.O.U. No. 506.0



Range

 Breeding



RANGE: Breeding: Eastern Massachusetts, w. to North Dakota, s. to the Gulf States. Winter: Mexico and n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Breeding: Orchards, woodland margins and open woodlands (avoids dense forest), shade trees along country roads and in suburbs. Prefers open, cultivated lands near human dwellings. Favors low elevations.

REPRODUCTION: Egg dates: May 18 to June 22, New York (Bull 1974:530). Clutch size: 3 to 7, typically 4 or 5. Incubation period: 12 to 14 days. Nestling period: 11 to 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 4 to 70 feet (1.2 to 21.3 m). Typically 10 to 20 feet (3 to 6.1 m). Nest site: Nest is suspended between two horizontally forked branches of a tree or shrub and is well concealed by dense foliage.

POPULATION DENSITIES: Maryland — 29 territorial males per 100 acres (40 ha) in farmyards. 15 territorial males per 100 acres (40 ha) in suburban residential area. 10 territorial males per 100 acres (40 ha) in shrubby field with stream-bordered trees (Stewart and Robbins 1958:323).

FEEDING: Major foods: Insects represent more than 90 percent of diet, wild fruits form the remainder. Substrate: Leaf surfaces. Technique: Leaf gleaning.

COMMENTS: Migrates south early (July-August). Stomachs of 11 birds taken in May and June in Maryland contained 91 percent animal and 9 percent vegetable material (Judd 1902 in Bent 1958:200).

KEY REFERENCES: Bent 1958, Dennis 1948.


Northern Oriole

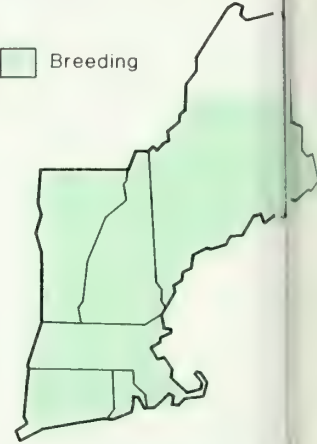
(*Icterus galbula*)

A.O.U. No. 507.0



Range

 Breeding



RANGE: Breeding: Nova Scotia, w. to British Columbia, s. to Georgia, Mexico and s. California. Winter: Mexico to n. South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Suburban shade trees of lawns and roadsides, groves, orchards, parks, deciduous woodland edges and along streams and lakes. Wintering: Locally at feeding stations where fruits and suet are provided.

SPECIAL HABITAT REQUIREMENTS: Tall deciduous trees, prefers elms.

NESTING: Egg dates: May 15 to June 13, New York (Bull 1974:530). Clutch size: 4 to 6, typically 4 or 5. Incubation period: 12 to 14 days. Nestling period: 11 to 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 6 to 60 feet (1.8 to 18.3 m). Typically 25 to 30 feet (7.6 to 9.1 m). Nest site: Usually high in a deciduous tree, often elm maple, willow, or apple. Nest is deeply pendant and is usually attached by its rim to tip of drooping branch. Nests in maples — shallow basket placed toward top-center of crown.

SAMPLE DENSITIES: 20 pairs per square mile (8 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 10 territorial males per 100 acres (40 ha) in shrubby field with stream-bordered trees in Maryland (Stewart and Robbins 1958:324).

FORAGING: Major foods: Insects, fruit. Substrates: leaf and twig surfaces. Techniques: Foliage and twig gleaning.

COMMENTS: The diet is mainly animal material (83 percent) and is supplemented by lesser amounts of vegetable material (17 percent), mostly fruits (Ford 1913:226). Formerly Baltimore Oriole.

KEY REFERENCES: Bent 1958, Forbush 1929.

Line Grosbeak

(*Pinicola enucleator*)

O.U. No. 515.0



Range



Permanent



Winter



RANGE: Breeding: Boreal forests of Canada, s. to Nova Scotia, n. New England, Manitoba, and the Rocky Mountains. Winter: Wanders s. irregularly to Maryland, Indiana, and Nebraska.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon and irregular.

HABITAT: Breeding: Northern spruce-fir forests, typically at high elevations, usually at edge of open area in forest or along forest border. Wintering: May remain in breeding areas or move south to open cedar-strewn hillsides, residential areas with feeders, orchards, street trees.

SPECIAL HABITAT REQUIREMENTS: Coniferous forests.

REPRODUCTION: Clutch size: 2 to 5, typically 4. Incubation period: 13 to 14 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest site: Low in coniferous tree (often spruce) or shrub.

FEEDING: Major foods: Buds, seeds, some insects in spring and summer. Substrates: Ground, branches. Techniques: Ground gleaning, budding.

COMMENTS: Winter diet: 99.1 percent vegetable, 0.9 percent animal (365 stomachs). Summer diet: 84 percent vegetable, 16 percent animal (29 stomachs) (Gabrielson 1984 in Bent 1968:330).

REFERENCES: Bent 1968, Harrison 1975.


Purple Finch

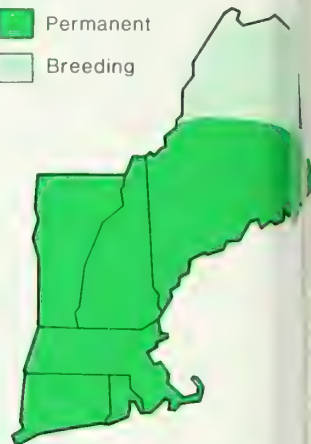
(*Carpodacus purpureus*)

A.O.U. No. 517.0



Range

-  Permanent
-  Breeding



RANGE: Breeding: Newfoundland, w. to British Columbia, s. to the mountains of Maryland, Illinois, and the mountains of California. Winter: Northern New England, w. to Wisconsin, s. to Georgia and Texas, British Columbia, s. to s. California and Arizona.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (s. Connecticut).

HABITAT: Breeding: Edges of coniferous forests, evergreen plantations, ornamental conifers in residential areas, parks, open mixed woodlands. Wintering: Largely deciduous woodlands. Common at feeding stations.

SPECIAL HABITAT REQUIREMENTS: Coniferous trees.

NESTING: Egg dates: May 13 to July 16, New York (Bull 1974:556). Clutch size: 3 to 6, typically 4 or 5. Incubation period: 13 days. Broods per year: 1 or 2. Nest height: 5 to 60 feet (1.5 to 18.3 m). Nest site: Typically on horizontal branch of a conifer (commonly spruce), often near top of tree.

FORAGING: Major foods: Over 70 percent vegetable matter, especially seeds of conifers, weeds and grasses, buds, fruits. Also takes insects, spiders, and other small invertebrates. Substrates: Branches. Technique: Branch gleaning.

COMMENTS: Ornamental conifers and Christmas tree plantations have influenced the southward range expansion of this species (Harrison 1975:230).

KEY REFERENCES: Bent 1968, Pough 1949.

House Finch

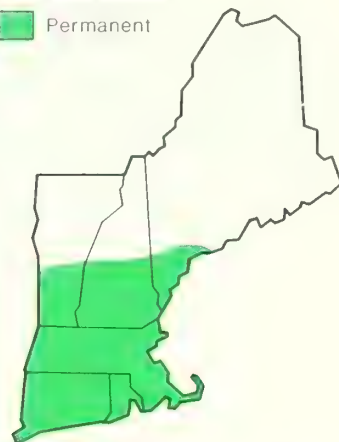
(*Carpodacus mexicanus*)

O.U. No. 519.0



Range

 Permanent



RANGE: Breeding: Introduced to New York City and spread to c. New England, Pennsylvania, New Jersey, Maryland, and Delaware. The western (native) range extends from British Columbia to s. Mexico. Winter: Same as breeding range.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (breeding rapidly northward throughout New England).

HABITAT: Breeding: Rural, suburban and urban yards, city parks, farms, open woods. Wintering: Same as breeding habitat.

SOCIAL HABITAT REQUIREMENTS: Birds may require open ground with low seed-producing plants and fruits and berries during part of year (Elliott and Arbib 1953).

NESTING: Egg dates: April 11 to July 20, New York (Bull 1944:560). Clutch size: 2 to 6, typically 4 or 5. Incubation period: 12 to 16 days. Nestling period: Average 15 days, range 11 to 19 days (Evenden 1957). Broods per year: 2 or more. Age at sexual maturity: 1 year. Nest height: 3 to 20 feet (0.9 to 6.1 m). Nest site: Uses a variety of sites including buildings, ledges, tree cavities, bird houses, vines (especially ivy) on buildings. In the Eastern United States, birds seem to be associated with conifers, especially cultivated varieties such as arbor-vitae and hedges (Elliott and Arbib 1953).

FEEDING: Major foods: Weed seeds, wild and cultivated fruit, insects. Substrates: Weeds and grasses. Technique: Ground gleaning.

COMMENTS: The House Finch was introduced to the Northeast in the 1940's (New York City area) from California by illegal pet trade. Its range has expanded to include much of the Northeast. About 97 percent of diet of 1,206 stomachs was vegetable matter (Beal 1907 in Bent 1968:306).

KEY REFERENCES: Bent 1968, Elliott and Arbib 1953, Evenden 1957, Harrison 1975.

Red Crossbill


(*Loxia curvirostra*)

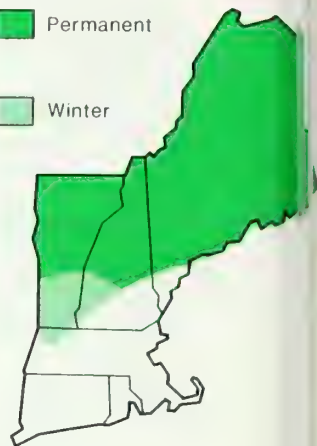
A.O.U. No. 521.0



Range

 Permanent

 Winter



RANGE: Breeding: Newfoundland, w. to Alaska, s. to n. New England, n. Georgia (mountains), Minnesota and the western mountains s. to Central America. Winter: South to the Gulf Coast (irregularly).

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common (Maine — coastal islands) to rare (inland).

HABITAT: Breeding: Coniferous forests from wooded marine islands to mountain tops. Wintering: Coniferous woods.

SPECIAL HABITAT REQUIREMENTS: Coniferous trees.

NESTING: Egg dates: March 30 to April 30, New York (Bull 1974:566). Clutch size: 3 to 5, typically 4. Incubation period: 12 to 14 days. Nestling period: 15 to 17 days. Broods per year: 1. Age at sexual maturity: 1 year. Nest height: 5 to 80 feet (1.5 to 24.4 m). Typically 10 to 40 feet (3.0 to 12.2 m). Nest site: On horizontal branch of conifer, usually hidden in a tuft of needles, well out from trunk.

TERRITORY SIZE: Defends a small area around the nest (Lawrence 1949).

FORAGING: Major foods: Seeds of conifers, hardwoods, and annual weeds; buds, wild fruits. Substrates: Tips of branches of trees, ground, bunches of conifer needles. Techniques: Branch, twig, cone, and foliage gleaning.

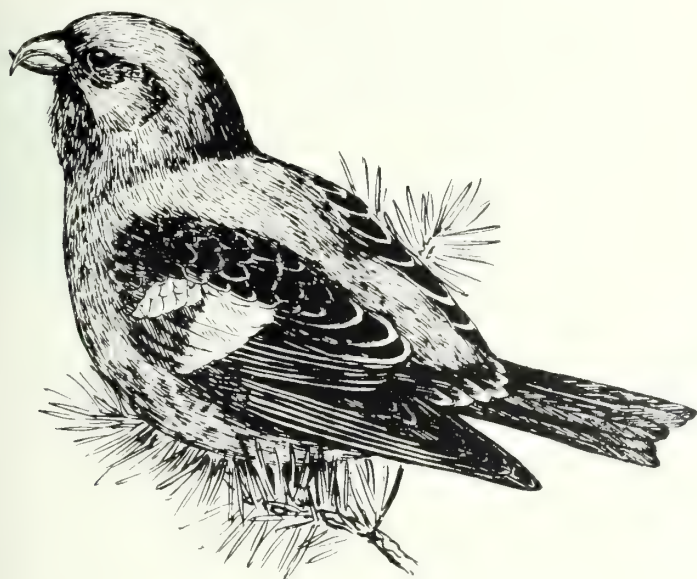
COMMENTS: Crossbills are attracted to highways in winter by road salt. Breeding periods are irregular with nesting reported in all months of the year; may be governed by food supply.

KEY REFERENCES: Bent 1968, Griscom 1937, Lawrence 1949.

White-winged Crossbill

(*Loxia leucoptera*)

A.O.U. No. 522.0



Range

 Permanent



RANGE: Breeding: Coniferous forests of Canada, s. to n. New England, Minnesota, and British Columbia. Winter: Irregularly s. to North Carolina, Illinois, and n. Oregon.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Breeding: Coniferous forests. Wintering: Coniferous forests.

SPECIAL HABITAT REQUIREMENTS: Coniferous forests.

NESTING: Clutch size: 2 to 5. Nest site: Horizontal limb of spruce. Nest heights vary considerably with some reported in low spruce shrubs and others at tops of 70-foot (11-m) trees. Reportedly nests in pines and other conifers, though less frequently.

FEEDING: Major foods: Seeds of conifers, hardwood trees especially birch and alder; weed seeds, fruits, small amounts of insects. Substrates: Branches of evergreens, clumps of needles. Techniques: Extracting seeds from conifer cones.

COMMENTS: Breeding is erratic with nesting reported from January to December. Breeding habits are little known.

KEY REFERENCE: Bent 1968.

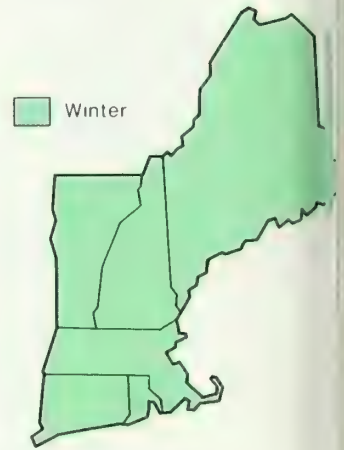
Common Redpoll

(*Carduelis flammea*)

A.O.U. No. 528.0



Range



RANGE: Breeding: Southern Newfoundland, w. to n. British Columbia. Winter: Wanders s. to North Carolina, Colorado and n. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon and irregular.

HABITAT: Wintering: Near alders and birches, the seeds of which are an important winter staple. Snow-covered weedy fields.

FORAGING: Major foods: Seeds of weeds, grasses, conifers, birches, and alders. Substrate: Ground. Techniques: Ground gleaning, opening seed heads.

KEY REFERENCE: Bent 1968.

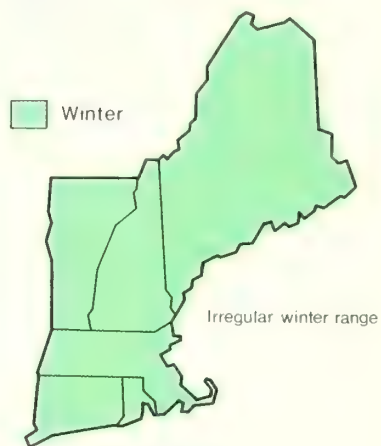
Gray Redpoll

(*Parus hornemanni*)

O.U. No. 527.0



Range



AGE: Breeding: Northern Alaska to n. Quebec. Win-
Irregularly s. to n. border states.

ATIVE ABUNDANCE IN NEW ENGLAND: Rare.

ATAT: Old fields, pastures, and birch or alder
raps.

ONGING: Major foods: Seeds of birches, alders and
rnon grasses. Substrates: Ground. Techniques:
rond gleaning, opening seed heads.

EYREFERENCE: Forbush 1929.

Pine Siskin


(*Carduelis pinus*)

A.O.U. No. 533.0



Range

 Permanent

 Winter



RANGE: Breeding: Quebec, west to Alaska, south to n. New England, North Carolina (mountains). Occurs rarely and erratically in n. Pennsylvania, s. New York and s. New England. Winter: Breeding range south to Florida, the Gulf States and Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon in breeding season. Abundant to rare (very irregular) in winter.

HABITAT: Breeding: Coniferous forests, natural conifer stands or evergreen plantations, alder thickets, weed patches adjacent to forests.

SPECIAL HABITAT REQUIREMENTS: Conifers.

NESTING: Egg dates: April 25 to May 25, New York (Bull 1974:564). Clutch size: 2 to 6, typically 3 or 4. Incubation period: 13 days. Nestling period: About 15 days. Age at sexual maturity: 1 year. Nest height: 6 to 35 feet (1.8 to 10.7 m). Typically 20 feet (6.1 m). Nest site: Usually nests in loose colonies. Nest is usually on a horizontal branch of a conifer and well out from the trunk. Nests exclusively in conifers.

TERRITORY SIZE: Small area 3 to 6 feet (0.9 to 1.8 m) in diameter surrounding nest (Weaver and West 1943).

FORAGING: Major foods: Summer — Insects, buds, seeds, tender leaves. Winter — Seeds of annual weeds, conifers, birches, and alders. Substrates: Ground, cone-bearing branches, especially in tops of trees. Techniques: Ground gleaning, opening seed heads.

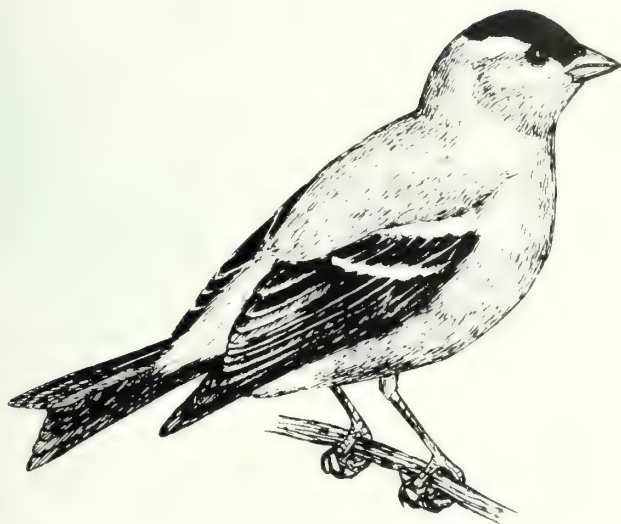
COMMENTS: Siskins usually breed at elevations of 3,000 feet (914 m) or more in New York, Vermont, and New Hampshire; lower in Maine. Birds feed in flocks in all seasons of the year. Numbers seem to fluctuate with crop conditions.

KEY REFERENCES: Bent 1968, Rodgers 1937, Weaver and West 1943.

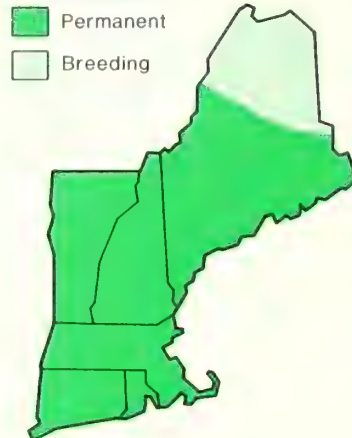
American Goldfinch

(*Carduelis tristis*)

O.U. No. 529.0



Range



RANGE: Breeding: Newfoundland, w. to British Columbia, s. to Georgia, Colorado, and s. California. Winter: Central Maine, s. to Florida, the Gulf States and Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeding: Open weedy fields, pastures with scattered trees near villages and farms, forest edges, swamps. Wintering: Woodlands.

ENVIRONMENTAL HABITAT REQUIREMENTS: Open weedy fields, scattered woody growth for nesting.

REPRODUCTION: Egg dates: July 3 to September 16, New York (Stokes 1974:563). Clutch size: 4 to 6, typically 5. Incubation period: 12 to 14 days. Nestling period: 11 to 15 days. Fledglings per year: 1 or 2. Age at sexual maturity: 1 year. Nest height: 1 to 90 feet (0.3 to 27.4 m). Typically 4 to 40 feet (1.2 to 12.2 m). Nest site: Usually in a fork formed by two upright branches or on a horizontal limb of a tree.

TERRITORY SIZE: Goldfinches do not always show strong territorial behavior (Nickell 1951). Average territory size: 38 pairs was an area 95 feet (20 m) in diameter in a marsh in Wisconsin (Stokes 1950).

POPULATION DENSITIES: 38 pairs per 6.4 acres (2.6 ha) of dry fields in Wisconsin (Stokes 1950). 40 pairs per square mile (15 pairs per km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972). 21 territorial males per 40 acres (40 ha) in shrubby field with stream-bordered fields in Maryland (Stewart and Robbins 1958:345).

FORAGING: Major foods: Insects, buds, succulent vegetation (in summer); seeds of weeds, birches, alders, conifers (in winter). Substrates: Tips of weed stalks, fruit-bearing branches of trees and shrubs. Techniques: Ground, shrub and leaf gleaning, breaking open seed heads. Preferred feeding habitat: Feeding areas may be a mile or more from nest site (Drum 1939).

COMMENTS: Late nesting coincides with seed production of thistles. The Canada thistle and dandelion are important for food and nesting material (Nickell 1951).

KEY REFERENCES: Bent 1968, Nickell 1951, Stokes 1950, Walkinshaw 1938a, 1939a.

Evening Grosbeak


(*Coccothraustes vespertinus*)

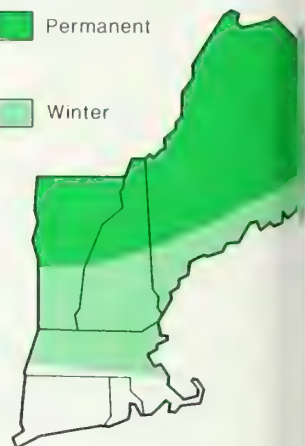
A.O.U. No. 514.0



Range

 Permanent

 Winter



RANGE: Breeding: Nova Scotia, w. to British Columbia, s. to n. New England, Minnesota, Mexico (mountains), and California. Winter: Breeding range s. to South Carolina, Texas, and California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common (Maine) to uncommon (Berkshire Hills) in breeding season. Irregularly common in winter.

HABITAT: Breeding: Coniferous forests. Wintering: Coniferous and deciduous woodlands.

SPECIAL HABITAT REQUIREMENTS: Coniferous forests.

NESTING: Egg dates: May 19 to June 4, New York (Bull 1974:553). Clutch size: 2 to 5, typically 3 or 4. Broods per year: Possibly 2 (Bull 1974:553). Nest height: 20 to 60 feet (6.1 to 18.3 m). Nest site: Usually in a conifer, occasionally in a deciduous tree.

FORAGING: Major foods: Buds, fruits, seeds, insects. Substrates: Branches of trees. Techniques: Branch gleaning, budding.

COMMENTS: Evening Grosbeaks feed extensively on spruce budworm during outbreaks in the northern forests. In winter they often invade feeding stations in large flocks to feed on sunflower seeds. Breeding habits are little known.

KEY REFERENCES: Belknap 1973, Bent 1968, Parks and Parks 1963.

House Sparrow

(*Passer domesticus*)

D.U. No. 688.2



Range

 Permanent



RANGE: Breeding: Throughout inhabited portions of the United States n. to c. Canada. Winter: Same.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Breeding: Villages, farms, cities, parks. Avoids heavily forested areas. Wintering: Same as breeding habitat.

REPRODUCTION: Egg dates: March 23 to July 16, New York (Bull 1971:542). Clutch size: 3 to 7, typically 5. Incubation period: 12 to 13 days. Nestling period: 13 to 18 days. Broods per year: 2 or 3. Age at sexual maturity: 1 year. Nest height: 10 to 50 feet (3.0 to 15.2 m). Nest site: Cavities, crevices in buildings, trees, billboards, birdhouses, cupolas, rafters, dense ivy on buildings.

TERRITORY SIZE: Defense is limited to the nest site.

POPULATION DENSITIES: C. A. North (1972) had 3.4 breeding pairs per acre (0.4 ha) on his 160-acre (64.8-ha) study area. 80 pairs per square mile (30 pairs/km²) in favorable habitat in North Dakota (Stewart and Kantrud 1972).

FEEDING: Major foods: Insects, vegetables, fruits and seeds (summer), weed seeds and waste grains (winter), garbage. Substrates: Sparsely vegetated or bare earth, pavement. Techniques: Hopping and gleaning, food on ground. Preferred feeding habitat: City parks, residential areas, waste grain fields.

COMMENTS: Birds are gregarious when feeding and roosting. The House Sparrow competes successfully for nesting cavities and often usurps them from more desirable species of birds. A pair that has bred usually keeps the same nest site for life. Exceptions occur where sites are plentiful.

KEY REFERENCES: North 1972, Summers-Smith 1958, Weaver 1942.

Literature Cited

- Adkisson, C. S. The nesting and behavior of mockingbirds in northern lower Michigan. *Jack-Pine Warbler*. 44: 102-116; 1966.
- Ailes, I. W.; Toepfer, J. E. Home range and daily movements of radio-tagged upland sandpipers in central Wisconsin. *IBB News*. 49: 203-212; 1977.
- Aldrich, J. W. The Hungarian and Chukar Partridges in America. *Wildl. Leafl.* 292. Washington, DC: U.S. Fish and Wildlife Services; 1947.
- Allen, A. A. The crested flycatcher's story. *Bird-Lore*. 35(4): 285-293; 1933a.
- Allen, A. A. The indigo bunting. *Bird-Lore*. 35: 227-235; 1933b.
- Allen, A. A. The golden plover and other birds. *American Bird Biographies*. Second series. Ithaca, NY: Comstock Publishing Co.; 1939. 324 p.
- Allen, D., ed. Pheasants in North America. Harrisburg, PA: Stackpole Company; Washington, DC: Wildlife Management Institute; 1956. 490 p.
- Allen, R. W.; Nice, M. M. A study of the breeding biology of the purple martin (*Progne subis*). *American Midland Naturalist*. 47(3): 606-665; 1952.
- American Ornithologists' Union. Checklist of North American birds. 6th ed. Washington DC: American Ornithologists' Union; 1983. 877 p.
- Andrle, R. F. Range extension of the golden-crowned kinglet in New York. *Wilson Bulletin*. 83: 313-316; 1971.
- Angell, T. Owls. Seattle, WA: University Washington Press; 1974. 80 p.
- Armstrong, E. A. Territory in the wren (*Troglodytes troglodytes*). *Ibis*. 98: 430-437; 1956.
- Armstrong, J. T. Breeding home range in the nighthawk and other birds; its evolutionary and ecological significance. *Ecology*. 46: 619-629; 1965.
- Armstrong, W. H. Nesting and food habits of the long-eared owl in Michigan. *Michigan State University Biological Series*. 1: 63-96; 1958.
- Baker, B. W. Nesting of the American redstart. *Wilson Bulletin*. 56: 83-90; 1944.
- Balgooyen, T. G. Behavior and ecology of the American Kestrel (*Falco sparverius* L.) in the Sierra Nevada of California. University of California Publication in Zoology. 103: 1-83; 1976.
- Bateman, H. A., Jr. King rail (*Rallus elegans*). In: Sanderson, Glen C., ed. Management of migratory shore and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 93-104.
- Baumgartner, F. M. Territory and population in the great horned owl. *Auk*. 56: 274-282; 1939.
- Beal, F. E. L.; McAtee, W. L.; Kalmbach, E. R. Common birds of southeastern United States in relation to agriculture. U.S. Department Agric. Farmer's Bull. 755; 1916: 34-35.
- Beecham, J. J.; Kochert, M. N. Breeding biology of the golden eagle in southwestern Idaho. *Wilson Bulletin*. 87: 506-513; 1975.
- Beecher, W. J. Nesting birds and the vegetation strate. Chicago, IL: Chicago Ornithological Society; 1942. 69 p.
- Belknap, J. B. The evening grosbeak in New York State. *Kingbird*. 23: 122-124; 1974.
- Bellrose, F. C. Ducks, geese, and swans of North America. Harrisburg, PA: Stackpole Books; 1976. 544 p.
- Bellrose, F. C.; Johnson, K. L.; Meyers, T. U. Relative value of natural cavities and nesting houses for wild ducks. *Journal of Wildlife Management*. 28: 676; 1964.
- Bengtson, S. Location of nest-sites of ducks in the Myvatn area, northeast Iceland. *Oikos*. 21: 218-220; 1970.
- Bennett, L. J. The blue-winged teal. Ames, IA: C. J. Bennett Press; 1938. 144 p.
- Bent, A. C. Life histories of North American diurnal birds. U.S. Natl. Mus. Bull. 107. Washington, DC: U.S. National Museum; 1919. 245 p.
- Bent, A. C. Life histories of North American gulls and terns. U.S. Natl. Mus. Bull. 113. Washington, DC: U.S. National Museum; 1921. 337 p.
- Bent, A. C. Life histories of North American wild birds. Part I. U.S. Natl. Mus. Bull. 126. Washington, DC: U.S. National Museum; 1923. 244 p.
- Bent, A. C. Life histories of North American marsh birds. U.S. Natl. Mus. Bull. 135. Washington, DC: U.S. National Museum; 1926. 490 p.
- Bent, A. C. Life histories of North American shore birds. Part I. U.S. Natl. Mus. Bull. 142. Washington, DC: U.S. National Museum; 1927. 420 p.
- Bent, A. C. Life histories of North American shore birds. Part II. U.S. Natl. Mus. Bull. 146. Washington, DC: U.S. National Museum; 1929. 412 p.
- Bent, A. C. Life histories of North American gallinaceous birds. U.S. Natl. Mus. Bull. 162. Washington, DC: U.S. National Museum; 1932. 477 p.
- Bent, A. C. Life histories of North American birds of prey. Part I. U.S. Natl. Mus. Bull. 167. Washington, DC: U.S. National Museum; 1937. 409 p.
- Bent, A. C. Life histories of North American birds of prey. Part II. U.S. Natl. Mus. Bull. 170. Washington, DC: U.S. National Museum; 1938. 495 p.
- Bent, A. C. Life histories of North American woodpeckers. U.S. Natl. Mus. Bull. 174. Washington, DC: U.S. National Museum; 1939. 334 p.
- Bent, A. C. Life histories of North American cuckoo, goatsuckers, hummingbirds, and their allies. U.S. Natl. Mus. Bull. 176. Washington, DC: U.S. National Museum; 1940. 506 p.
- Bent, A. C. Life histories of North American flycatchers, larks, swallows, and their allies. U.S. Natl. Mus. Bull. 179. Washington, DC: U.S. National Museum; 1942. 555 p.
- Bent, A. C. Life histories of North American jays, crows, and titmice. Parts I and II. U.S. Natl. Mus. Bull. 180. Washington, DC: U.S. National Museum; 1946. 500 p.

- t, A. C. Life histories of North American nuthatches, wrens, thrashers and their allies. U.S. Natl. Mus. Bull. 195. Washington, DC: U.S. National Museum; 1948. 475 p.
- t, A. C. Life histories of North American thrushes, kinglets and their allies. U.S. Natl. Mus. Bull. 196. Washington, DC: U.S. National Museum; 1949. 454 p.
- t, A. C. Life histories of North American wagtails, shrikes, vireos and their allies. U.S. Natl. Mus. Bull. 197. Washington, DC: U.S. National Museum; 1950. 400 p.
- t, A. C. Life histories of North American wood warblers. Parts I and II. U.S. Natl. Mus. Bull. 203. Washington, DC: U.S. National Museum; 1953. 734 p.
- t, A. C. Life histories of North American blackbirds, orioles, tanagers, and allies. U.S. Natl. Mus. Bull. 211. Washington, DC: U.S. National Museum; 1958. 549 p.
- t, A. C. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. Parts I, II, and III. U.S. Natl. Mus. Bull. 237. Washington, DC: U.S. National Museum; 1968. 1889 p.
- ger, A. J. Nesting density of Virginia and sora rails in Michigan. Condor. 53: 202; 1951.
- in, R. I. Breeding habitats of the wood thrush and veery. Condor. 79: 303-311; 1977.
- L. B. Territory quality and mating success in the field sparrow (*Spizella pusilla*). Condor. 79: 192-203; 1977.
- L. B. Field sparrow reproductive success and nesting ecology. Auk 95:9-22; 1978.
- er, L. K. Nest life of the bank swallow. Wilson Bulletin. 50: 22-137; 1938.
- r, R. D.; Smith, L. B. The food habits of the red-winged blackbird (*Agelaius phoeniceus*) in Manitoba. Canadian Field-Naturalist. 78: 179-186; 1964.
- cher, A. Cowbirds. Oologist. 53(10): 131-133; 1936.
- oll, R. R. Ecological distribution of breeding birds in the upland forests of southern Wisconsin. Ecological Monographs. 27: 351-384; 1957.
- ovich, B. S.; Philipp, P. B. The Tennessee warbler in New Brunswick. Auk. 33: 1-8; 1916.
- oy, E. M. A half-century's changes in the bird-life around Springfield, Massachusetts. Bird-Banding. 3: 137-148; 1962.
- aley, H. L. A life history study of the indigo bunting. Black-Pine Warbler. 26: 103-113; 1948.
- retenridge, W. J. Measurements of the habitat niche of the least flycatcher. Wilson Bulletin. 68: 47-51; 1956.
- reer, R. Size of home range in eight bird species in a southern Illinois swamp-thicket. Wilson Bulletin. 67: 140-141; 1955.
- reer, R. Breeding-bird populations of strip-mined land in Perry Co., Ill. Ecology. 39: 543-545; 1958.
- Brewer, R. Comparative notes on the life history of the Carolina chickadee. Wilson Bulletin. 73: 348-373; 1961.
- Brewster, W. Notes on the Lincoln's finch. October Farm, Cambridge, MA: Harvard University Press; 1936: 138-143.
- Broley, C. L. Migration and nesting of Florida bald eagles. Wilson Bulletin. 59: 3-20; 1947.
- Brown, L. Birds of prey: their biology and ecology. London: Hamlyn; 1976. 256 p.
- Bryant, L., Jr. Some notes on the breeding of the vesper sparrow. Bird-Banding. 2:178-184; 1931.
- Buckley, P. A.; Paxton, R. P.; Cutler, D. The nesting season: Hudson-Delaware region. American Birds. 30(5): 932-938; 1976.
- Bull, E. Habitat utilization of the pileated woodpecker, Blue Mountains, Oregon. Corvallis, OR: Oregon State University; 1975. 58 p. M.S. thesis.
- Bull, J. Birds of the New York area. New York: Harper & Row; 1964. 540 p.
- Bull, J. Birds of New York State. Garden City, NY: Doubleday Natural History Press; 1974. 655 p.
- Bull, J.; Farrand, J., Jr. The Audubon Society field guide to North American birds: Eastern region. New York: Alfred A. Knopf, Inc.; 1977. 775 p.
- Bump, G.; Darrow, R. W.; Edminster, F. C.; Crissy, W. F. The ruffed grouse: Life history, propagation, management. Albany, NY: New York Conservation Department; 1947. 896 p.
- Burleigh, T. D. Georgia birds. Norman, OK: University of Oklahoma Press; 1958.
- Burns, F. L. A monograph of the broad-winged hawk (*Buteo platyperus*). Wilson Bulletin. 23: 139-320; 1911.
- Burton, J. A., ed. Owls of the world. New York: E. P. Dutton Co.; 1973. 216 p.
- Buss, I. O.; Hawkins, A. S. The upland plover at Faville Grove, Wisconsin. Wilson Bulletin. 51: 202-220; 1939.
- Butts, W. K. A study of the chickadee and white-breasted nuthatch by means of marked individuals. Bird-Banding. 2: 1-26; 1931.
- Cade, T. C. Ecological and behavior aspects of predation by the northern shrike. Living Bird. 6: 43-86; 1967.
- Carter, B. C. The American goldeneye in central New Brunswick. Canadian Wildlife Service Wildlife Management Bulletin. Series 2(9): 1-47; 1958.
- Case, N. A.; Hewitt, O. H. Nesting and productivity of the red-winged blackbird in relation to habitat. Living Bird. 2: 7-20; 1963.
- Chabreck, R. H. Breeding habits of the pied-billed grebe in an impounded coastal marsh in Louisiana. Auk 80: 447-452; 1963.
- Chapman, F. The warblers of North America. New York: D. Appleton and Co.; 1907. 306 p.
- Chapman, L. B. Studies of a tree swallow colony. Bird-Banding. 26: 45-70; 1955.

- Clark, R. J. A field study of the short-eared owl (*Asio flammeus*) (Pontoppidan) in North America. Wildl. Monogr. No. 47. Washington, DC: The Wildlife Society; 1975. 67 p.
- Collins, H. H., Jr.; Boyajian, N. R. Familiar garden birds of America. New York: Harper and Row; 1965. 309 p.
- Conner, R. N. Nesting habitat for red-headed woodpeckers in southwestern Virginia. Bird-Banding. 47: 40-43; 1976.
- Conner, R. N., and C. S. Adkisson. Eastern Bluebirds nesting in clearcuts. Journal of Wildlife Management. 38: 934-935; 1974.
- Conner, R. N.; Hooper, R. G.; Crawford, H. S.; Mosby, H. S. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. Journal of Wildlife Management. 39: 144-150; 1975.
- Cornwell, G. W. Observations on the breeding biology and behavior of a nesting population of belted kingfishers. Condor. 65: 426-431; 1963.
- Cottrille, W. P.; Cottrille, B. D. Great blue heron: Behavior at the nest. Miscellaneous Publication Museum of Zoology University of Michigan 102: 1-15; 1958.
- Coulter, M. W. Food of wood ducks in Maine. Journal of Wildlife Management. 21: 235-236; 1957.
- Coulter, M. W.; Miller, W. R. Nesting biology of black ducks and mallards in northern New England. Vermont Fish and Game Department Bulletin. 68(2): 1-74; 1968.
- Cowardin, L. M.; Carter, V.; Golet, F. C.; LaRoe, E. T. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service; 1979. 103 p.
- Cox, G. W. A life history of the mourning warbler. Wilson Bulletin. 75: 5-28; 1960.
- Craighead, J.; Craighead, F. Hawks, owls and wildlife. New York: Dover Publications; 1969. 443 p.
- Crooks, M. P. Life history of the field sparrow (*Spizella p. pusilla*). Ames, IA: Iowa State College; 1948. M.S. thesis.
- Crooks, M. P.; Hendrickson, G. O. Field sparrow life history in central Iowa. Iowa Bird Life. 23: 10-13; 1953.
- Cruz, A. Ecology and breeding biology of the solitary vireo. Journal of the Colorado-Wyoming Academy of Science. 7(6): 36-37; 1975.
- Davis, D. W. Observations on territorial behavior of least flycatchers. Wilson Bulletin. 71: 73-85; 1959.
- Davis, E. M. Observations on nesting barn swallows. Bird-Banding. 8: 66-73; 1937.
- Davis, J. Nesting behavior of the rufous-sided towhee in coastal California. Condor. 62: 434-456; 1960.
- DeGraaf, R. M. Suburban habitat associations of birds. Amherst, MA: University of Massachusetts; 1975. 295 p. Ph.D. dissertation.
- DeGraaf, R. M.; Pywell, H. R.; Thomas, J. W. Relationships between nest height, vegetation and housing density in New England suburbs. Transactions of the Northeast Wildlife Conference. 32: 130-150; 1967.
- Dennis, J. V. Observations on the orchard oriole in the lower Mississippi delta. Bird-Banding. 19: 1-10; 1948.
- Dennis, J. V. Some aspects of the breeding ecology of the yellow-breasted chat (*Icteria virens*). Bird-Banding. 29: 169-183; 1958.
- Dennis, J. V. The yellow-shafted flicker (*Colaptes cafer*) on Nantucket Island, Massachusetts. Bird-Banding. 40(4): 290-308; 1969.
- Dexter, R. W. Synopsis of the 1976 season for chimney swifts at Kent State University. Bird-Banding. 48: 73-74; 1977.
- Dilger, W. C. Adaptive modifications and ecological isolating mechanisms in the thrush, genera *Turdus* and *Hylocichla*. Wilson Bulletin. 68: 171-180; 1956.
- Dixon, C. L. Breeding biology of the savannah sparrow on Kent Island. Auk. 95: 235-246; 1978.
- Dow, D. D. Home range and habitat of the cardinal in peripheral and central populations. Canadian Journal of Zoology. 47: 103-115; 1969.
- Drewien, R. C.; Springer, P. F. Ecological relationships of breeding blue-winged teal to prairie potholes. Saskatoon Wetlands Seminar, Canadian Wildlife Service Report Series No. 6: 102-115; 1969.
- Drum, M. Territorial studies on the eastern goldfinch. Wilson Bulletin. 51: 69-77; 1939.
- Dunnett, G. M. The breeding of the starling (*Sturna vulgaris*) in relation to its food supply. Ibis. 97: 662; 1955.
- Dzubin, A. Some evidence of home range in waterfowl. Transactions of the Northeast Wildlife Conference. 20: 278-298; 1955.
- Earhart, C. M.; Johnson, N. K. Size dimorphism and food habits of North American owls. Condor. 72: 251-264; 1970.
- Eaton, S. W. A life history of the Louisiana waterthrush. Wilson Bulletin. 70: 211-236; 1958.
- Edminster, F. C. American game birds of field and forest. New York: Charles Scribner's Sons; 1954. 495 p.
- Elliott, J. J.; Arbib, R. S., Jr. Origin and status of house finch in the eastern United States. Auk. 70: 37; 1953.
- Ellison, L. N. Territoriality in Alaskan spruce grouse. Auk. 88: 652-664; 1971.
- Ellison, L. N. Seasonal social organization and movements of spruce grouse. Condor. 75: 375-385; 1973.
- Emlen, J. T., Jr. Social behavior in nesting cliff swallows. Condor. 54: 117-199; 1952.
- Emlen, J. T. Territory, nest building and pair formation in the cliff swallow. Auk. 71: 16-35; 1954.
- Emlen, S.; Demong, N. J. Adaptive significance of synchronized breeding in the bank swallow. Abstracts 92nd meeting. Norman, OK: American Ornithologists' Union; 1974: 8.

- erson, J. H. A population study of the sparrow hawk in east-central Illinois. *Wilson Bulletin*. 72:222-231; 1960.
- land, E. G. A nest of the arctic three-toed woodpecker. *Condor*. 42: 242-245; 1940.
- rkson, A. B. A study of Wilson's snipe. *Wilson Bulletin*. 53: 62; 1941.
- st, S. G. The food of the red-shouldered hawk in New York State. *Auk*. 62: 452-453; 1945.
- ngton, P. L.; McDonald, M. Conclusions as to the food habits of the barred owls in Iowa. *Iowa Bird Life*. 7: 47-49; 1937.
- ine, A. J. Buffleheads. Canadian Wildlife Service Monograph No. 4; 1971. 240 p.
- in, W. G. Some nesting habits of the brown thrasher. *Journal Tennessee Academy of Science*. 10: 179-204; 1935.
- is, C. D.; Black, K. E. Duck production studies on the prairie potholes of South Dakota. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. No. 32. Washington, DC: U.S. Fish and Wildlife Service; 1956. 59 p.
- iden, F. G., Jr. Observations on nesting behavior of the house finch. *Condor*. 59: 112-117; 1957.
- org, J. Habitat selection and territorial behavior of the small grebes of North Dakota. *Wilson Bulletin*. 88: 390-399; 1976.
- s, E. Bird-Lore's first breeding-bird census. Second-growth hardwood. *Bird-Lore*. 39(5): 380; 1937.
- s, E. Bird-Lore's second breeding-bird census. Second-growth hardwood. *Bird-Lore*. 40(5): 359; 1938.
- wer, B. J. Bird population of an Illinois flood plain forest. *Illinois Academy of Science Transactions*. 40: 178-189; 1947.
- hn, M. S. Agonistic behavior and territory in the American redstart. *Auk*. 79: 607-632; 1961.
- hn, M. S.; Ficken, R. W. Territorial relationships of blue-winged warblers, golden-winged warblers, and their hybrids. *Wilson Bulletin*. 80: 442-451; 1968.
- ck, R. W. Courtship and aggressive behavior of the common grackle (*Quiscalus quiscula*). *Auk*. 80: 52-62; 1963.
- ble, J. C. Breeding biology of purple martins at the northern limit of their range. *Wilson Bulletin*. 83: 25-269; 1971.
- cker, R. B. The breeding biology of the chimney swift (*Chaetura pelagica* L.). *New York State Mus. Sci. Serv. Bull.* 368. Albany, NY: New York State Museum; 1958. 141 p.
- cker, R. B.; Gills, G. A cooperative study of the white-throated sparrow. *Auk*. 63: 402-418; 1946.
- ch H. S. Home ranges, territories and seasonal movements of vertebrates of the Natural History Reservation. University of Kansas Publication Museum of Natural History. 11: 63-326; 1958.
- Fitch, H.S.; Swenson, F.; Tillotson, D. F. Behavior and food habits of the red-tailed hawk. *Condor*. 48: 205-237; 1946.
- Fogarty, M. J.; Arnold, K. A. Common snipe. In: Sanderson, Glen C., ed. Management of migratory shore and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 189-209.
- Forbush, E. H. Useful birds and their protection. Boston, MA: Massachusetts State Board of Agriculture; 1913. 451 p.
- Forbush, E. H. Birds of Massachusetts and other New England states. Boston, MA: Massachusetts Department of Agriculture; 1929. 3 vol.
- Forbush, E. H.; May, J. B. Natural history of the birds of eastern and central North America. Boston, MA: Houghton Mifflin Co.; 1939. 554 p.
- Franks, E. C.; Martin, W. Thirty-first breeding-bird census. Upland oak-hickory forest. *Audubon Field Notes*. 21(6): 615; 1967.
- Fredrickson, L. H. Breeding biology of American coots in Iowa. *Wilson Bulletin*. 82: 445-457; 1970.
- Fredrickson, L. H. Common gallinule breeding biology and development. *Auk*. 88: 914-919, 1971.
- Fredrickson, L. H. American coot (*Fulica americana*). In: Sanderson, Glen C., ed. Management of migratory shore and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 123-147.
- Fretwell, S. Dominance behavior and winter habitat distribution in juncos (*Junco hyemalis*). *Bird-Banding*. 40(1): 1-25; 1969.
- Friedman, H. The cowbirds. Springfield, IL: Charles C. Thomas; 1929. 421 p.
- Friley, C. E.; Bennett, L. J.; Hendrickson, G. O. The American coot in Iowa. *Wilson Bulletin*. 50: 81-86; 1938.
- Fritz, R. S. The spruce grouse in the Adirondacks. *The Conservationist*. 31(4): 19-22; 1977.
- Gabrielson, I. N. Field observations on the rose-breasted grosbeak. *Wilson Bulletin*. 27: 357-368; 1915.
- Gates, J. M. Breeding ecology of the gadwall in northern Utah. *Wilson Bulletin*. 74: 43-67; 1962.
- Gates, J. M. Red-tailed hawk populations and ecology in east-central Wisconsin. *Wilson Bulletin*. 84: 421-433; 1972.
- Gillespie, M. Behavior and local distribution of the tufted titmouse in winter and spring. *Bird-Banding*. 1: 113-126; 1930.
- Glover, F. A. Nesting ecology of the pied-billed grebe in northwestern Iowa. *Wilson Bulletin*. 65: 32-39; 1953.
- Godfrey, W. E. The birds of Canada. Ottawa, On: National Museum of Natural Sciences; 1979, 428 p.
- Goodwin, D. Crows of the world. Ithaca, NY: Cornell University Press.; 1976. 359 p.

- Goodwin, D. Pigeons and doves of the world. 2nd ed. Ithaca, NY: Cornell University Press; 1977. 446 p.
- Gottfried, B. M.; Franks, E. C. Habitat use and flock activity of dark-eyed juncos in winter. *Wilson Bulletin*. 87: 374-383; 1975.
- Graber, J. W.; Graber, R. R.; Kirk, E. L. Illinois birds: Picidae. Illinois Natural History Survey Biological Notes No. 102: 1-73; 1977.
- Graber, R. R.; Graber, J. W. Nesting of the parula warbler in Michigan. *Wilson Bulletin*. 63: 75-83; 1951.
- Graber, R. R.; Graber, J. W. A comparative study of bird populations in Illinois, 1906-1909 and 1956-1958. *Illinois Natural History Survey Bulletin*. 28(3): 383-528; 1963.
- Graber, R. R.; Graber, J. W.; Kirk, E. L. Illinois birds: Mimidae. Illinois Natural History Survey Biological Notes. 68: 1-38; 1970.
- Graber, R. R.; Graber, J. W.; Kirk, E. L. Illinois birds: Turridae. Illinois Natural History Survey Biological Notes. 75: 1-44; 1971.
- Graber, R. R.; Graber, J. W.; Kirk, E. L. Illinois birds: Hirundinidae. Illinois Natural History Survey Biological Notes. 80: 1-36; 1972.
- Graber, R. R.; Graber, J. W.; Kirk, E. L. Illinois birds: Laniidae. Illinois Natural History Survey Biological Notes. 83: 1-18; 1973.
- Graber, R. R.; Graber, J. W.; Kirk, E. L. Illinois birds: Tyrannidae. Illinois Natural History Survey Biological Notes. 86: 1-56; 1974.
- Grice, D.; Rogers, J. P. The wood duck in Massachusetts. Final Rep. Fed. Aid in Wildl. Restor. Proj. W-19-R. Boston, MA: Division of Fisheries and Game; 1965. 96 p.
- Griscom, L. A monographic study of the red crossbill. *Proceedings of the Boston Society of Natural History*. 41: 77-210; 1937.
- Griscom, L.; Sprunt, A., Jr. The warblers of America. New York: Devin-Adair Co.; 1957. 356 p.
- Gross, A. O. The black-crowned night heron (*Nycticorax nycticorax naevius*) of Sandy Neck. *Auk*. 40: 1-30, 191-214; 1923.
- Gullion, G. W. Territorial behavior of the American coot. *Condor*. 55: 169-186; 1953.
- Gullion, G. W. Improving your forested lands for ruffed grouse. *Miscellaneous Journal Series Minnesota Agricultural Experiment Station Publication No.* 1439: 1-34; 1972.
- Hagar, D. C., Jr. Nesting populations of red-tailed hawks and horned owls in central New York. *Wilson Bulletin*. 69: 263-272; 1957.
- Hammond, D. E.; Wood, R. L. New Hampshire and the disappearing loon. Meredith, NH: Loon Preservation Committee; 1977. 16 p.
- Hann, H. W. Life history of the ovenbird in southern Michigan. *Wilson Bulletin*. 49: 145-237; 1937.
- Hansen, H. C.; Kossack, C. W. The morning dove in Illinois. Carbondale, IL: Southern Illinois University Press; 1962. 133 p.
- Hardin, K. I.; Evans, D. E. Cavity nesting bird habitat in the oak-hickory forests—a review. Gen. Tech. Rep. NC-30. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 23 p.
- Harding, K. C. Semi-colonization of veeries. *Northeastern Bird-Banding Association*. 1(1): 4-7; 1925.
- Harlow, R. C. The breeding habits of the northern raven in Pennsylvania. *Auk*. 39: 399-410; 1922.
- Harlow, R. F.; Hooper, R. G.; Chamberlain, D. J.; Crawford, H. S. Some winter and nesting seed foods of the common raven in Virginia. *Auk* 92: 306; 1975.
- Harrison, H. A field guide to birds' nests (in the United States east of the Mississippi River). Boston, MA: Houghton Mifflin; 1975. 350 p.
- Hartshorne, J. M. Behavior of the eastern bluebird at its nest. *Living Bird*. 1: 131-149; 1962.
- Hausman, L. A. Birds of prey of northeastern North America. Peterborough, NH: R.R. Smith, Publisher; 1966. 164 p.
- Hays, H. Polyandry in the spotted sandpiper. *Living Bird*. 11: 43-57; 1972.
- Hecht, W. R. Nesting of the marsh hawk at Delta, Mississippi. *Wilson Bulletin*. 63: 167-176; 1951.
- Henny, C. J.; Schmid, F. C.; Martin, E. M.; Hood, B. Territorial behavior, pesticides and the population ecology of red-shouldered hawks in central Mississippi. *Ecology*. 54: 545-554; 1973.
- Hespenheide, H. A. Flycatcher habitat selection in the eastern deciduous forest. *Auk* 88: 61-74; 1971.
- Hester, F. E.; Dermid, J. The world of the wood duck. New York: Lippincott Co.; 1973. 160 p.
- Heydweiller, A. M. A comparison of winter and summer territories and seasonal variations of the tree sparrow (*Spizella a. arborea*). *Bird-Banding*. 6: 1-13; 1935.
- Hickey, J. J. Eastern population of the duck hawk. *Auk*. 59: 176-204; 1942.
- Hickey, J. J. A guide to bird watching. New York: Oxford University Press; 1943. 262 p.
- Hickey, J. J., ed. Peregrine falcon populations: their biology and decline. Milwaukee, WI: University of Wisconsin Press; 1969. 596 p.
- Hickey, J. J.; Anderson, D. W. In: Hickey, J. J., ed. Peregrine falcon populations: their biology and decline. Milwaukee, WI: University of Wisconsin Press; 1969: 3-42.
- Hilden, O. Ecology of duck populations in the island group of Valassaret, Gulf of Bothnia. *Ann. Zoologici Fennici*. 1: 1-279; 1964.
- Hochbaum, H. A. The canvasback on a prairie marsh. Washington, DC: Wildlife Management Institute; 1944. 201 p.
- Hofslund, P. B. Cowbird parasitism of the northern yellowthroat. *Auk*. 74: 42-48; 1957.
- Holm, C. H. Breeding sex ratios, territoriality, and reproductive success in the red-winged blackbird (*Agelaius phoeniceus*). *Ecology*. 54: 356-365; 1973.

- per, R. G. Nesting habitat of common ravens in Virginia. *Wilson Bulletin*. 89: 233-242; 1977.
- per, R. G.; Crawford, H. S.; Chamberlain, D. R.; Harlow, R. F. Nesting density of common ravens in the ridge-valley region of Virginia. *American Birds*. 29: 931-935; 1975.
- per, R. G.; Dachelet, C. A. Flocks of non-breeding common ravens in Virginia. *The Raven*. 47(1): 23-24; 1976.
- J. Three-bird flights in the mallard. *Wildfowl Trust Annual Rept*. 14: 124-132; 1963.
- ard, D. V. Urban robins: A population study. In: Noyes, J. H.; Progulske, D. R., eds. *Wildlife in an urbanizing environment*. Plan. Res. Div. Ser. 28, Amherst, MA: Holdsworth Natural Resources Center, University of Massachusetts; 1974.
- ell, J. C. Notes on the nesting habits of the American Robin. *American Midland Naturalist*. 28: 529-603; 1942.
- ell, T. R. Natural history and differentiation in the yellow-bellied sapsucker. *Condor*. 54: 237-282; 1952.
- J. S. Y. Through the year with the pileated woodpecker. *Audubon*. 43(6): 525-528; 1941.
- J. S. F. The ecology of the pileated woodpecker. *Ecology*. 38: 246-256; 1957.
- e, A. S. The life history of Henslow's sparrow, *Passerherbulus henslowii* (Audubon). University of Michigan Museum Zoology Miscellaneous Publication No. 41: 172; 1939.
- on, J. A. A quantitative study of the foraging ecology of downy woodpeckers. *Ecology*. 51: 318-323; 1970.
- ti, L. R.; Hunt, R. A. Duck and coot ecology and management in Wisconsin. *Wisconsin Conservation Department Technical Bulletin*. 33: 1-212; 1964.
- is, R. D. Foraging behavior and habitat selection of three species of vireos in southern Ontario. *Wilson Bulletin*. 88: 62-75; 1976.
- sgard, P. A. Grouse and quails of North America. Lincoln, NE: University of Nebraska Press; 1973. 553 p.
- sgard, P. A. Waterfowl of North America. Bloomington, IN: Indiana University Press; 1975. 575 p.
- hilton, D. W. The biosystematics of American crows. Seattle, WA: University of Washington Press; 1961. 119 p.
- hilton, D. W. High density of birds breeding in a modified deciduous forest. *Wilson Bulletin*. 82: 79-82; 1970.
- hilton, D. W. Niche relationships among some deciduous forest flycatchers. *Auk*. 88: 796-804; 1971.
- hilton, D. W. Odum, E. Breeding bird populations in relation to plant succession on the Piedmont of Georgia. *Ecology*. 37: 50-62; 1956.
- hilton, V. R. Breeding birds of the forest edge in Illinois. *Condor*. 49: 45-53; 1947.
- Judd, S. D. The relation of sparrows to agriculture. *Bur. Biol. Surv. Bull.* 15. Washington, DC: U.S. Department of Agriculture; 1901.
- Jurek, R. M.; Leach, H. R. Shorebirds. In: Sanderson, Glen C., ed. *Management of migratory shore and upland game birds in North America*. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 301-320.
- Kale, H. W. II. Ecology and Bioenergetics of the long-billed marsh wren in Georgia salt marshes. *Publ. No. 5*, Cambridge, MA: Nuttall Ornithological Club; 1965. 142 p.
- Karr, J. R. Habitat and avian diversity on strip-mined land in east central Illinois. *Condor*. 70: 348-357; 1968.
- Keeler, J. E. Mourning dove (*Zenaida macroura*). In: Sanderson, Glen C., ed. *Management of migratory shore and upland game birds in North America*. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 275-298.
- Keith, L. B. A study of waterfowl ecology on small impoundments in southeastern Alberta. *Wildlife Monographs*. 6: 1-88; 1961.
- Kempton, R. M. Notes on the home life of the turkey vultures. *Wilson Bulletin*. 39: 142-145; 1927.
- Kendeigh, S. C. Birds of a prairie community. *Condor*. 43: 165-174; 1941a.
- Kendeigh, S. C. Territorial and mating behavior of the house wren. *University of Illinois Biological Monographs*. 18(3): 1-120; 1941b.
- Kendeigh, S. C. Community selection of birds on the Helderberg Plateau of New York. *Auk*. 62: 418-436; 1945a.
- Kendeigh, S. C. Nesting behavior of wood warblers. *Wilson Bulletin*. 57: 145-164; 1945b.
- Kendeigh, S. C. Breeding birds of the beech-maple-hemlock community. *Ecology*. 27: 226-245; 1946.
- Kennard, F. H. Notes on the breeding habits of the rusty blackbird in northern New England. *Auk*. 37: 412-422; 1920.
- Kessel, B. Second broods in the European starling in North America. *Auk*. 70: 479-483; 1953.
- Kessel, B. A study of the breeding biology of the European starling (*Sturnus vulgaris* L.) in North America. *American Midland Naturalist*. 58(2): 257-331; 1957.
- Kilham, L. Pair formation, mutual tapping, and nest hole selection of red-bellied woodpeckers. *Auk*. 75: 318-329; 1958a.
- Kilham, L. Territorial behavior of wintering red-headed woodpeckers. *Wilson Bulletin*. 70: 347-358; 1958b.
- Kilham, L. Courtship and territorial behavior of hairy woodpeckers. *Auk*. 77: 259-270; 1960.
- Kilham, L. Breeding behavior of yellow-bellied sapsuckers. *Auk*. 79: 31-43; 1962.

- Kilham, L. Food storing of red-bellied woodpeckers. *Wilson Bulletin*. 75: 227-234; 1963.
- Kilham, L. Differences in the feeding behavior of male and female hairy woodpeckers. *Wilson Bulletin*. 77: 134-143; 1965.
- Kilham, L. Reproductive behavior of hairy woodpeckers. II. Nesting and habitat. *Wilson Bulletin*. 80: 286-305; 1968a.
- Kilham, L. Reproductive behavior of white-breasted nuthatches. I. Distraction display, bill-sweeping and nest hole defense. *Auk*. 85: 477-492; 1968b.
- Kilham, L. Reproductive behavior of yellow-bellied sapsuckers. I. Preferences for nesting in *Fomes*-infected aspens and nest hold interrelations with flying squirrels, raccoons, and other animals. *Wilson Bulletin*. 83: 159-171; 1971.
- Kilham, L. Colonial-type nesting in yellow-shafted flickers as related to staggering of nesting times. *Bird-Banding*. 44: 317-318; 1973.
- Kilham, L. Covering of stores by white-breasted and red-breasted nuthatches. *Condor*. 76: 108-109; 1974.
- King, J. R. Notes on the life history of Traill's flycatcher. *Auk*. 72: 148-173; 1955.
- Kitchen, D. W.; Hunt, G. S. Brood habitat of the hooded merganser. *Journal of Wildlife Management*. 33: 605-609; 1969.
- Kluyver, H. M. Food consumption in relation to habitat in breeding chickadees. *Auk*. 78: 532-550; 1961.
- Kuerzi, R. G. Life history studies of the tree swallow. *Proceedings Linnean Society* No. 52-3: 1-52; 1941.
- Kushlan, J. A. Feeding behavior of North American herons. *Auk*. 93: 86-94; 1976.
- Lanyon, W. E. The comparative biology of the meadowlarks (*Sturnella*) in Wisconsin. Cambridge, MA: Nuttall Ornithological Club; 1957; Publ. No. 1. 67 p.
- Laskey, A. R. The 1939 nesting season of bluebirds at Nashville, Tennessee. *Wilson Bulletin*. 52: 183-190; 1940.
- Laskey, A. R. A study of the cardinal in Tennessee. *Wilson Bulletin*. 56: 27-44; 1944.
- Laskey, A. R. Some tufted titmouse life history. *Bird-Banding*. 28: 135-144; 1957.
- Laskey, A. R. The breeding biology of mockingbirds. *Auk*. 79: 596-606.
- Lawrence, L. de K. Five days with a pair of nesting Canada jays. *Canadian Field-Naturalist*. 61: 1-12; 1947.
- Lawrence, L. de K. Comparative study of the nesting behavior of chestnut-sided and Nashville warblers. *Auk*. 65: 204-219; 1948.
- Lawrence, L. de K. The red crossbill to Pimisi Bay, Ontario. *Canadian Field-Naturalist*. 63: 147-160; 1949.
- Lawrence, L. de K. Red-breast makes a home. *Audubon Magazine*. 54: 16-21; 1952.
- Lawrence, L. de K. Nesting life and behavior of the eyed vireo. *Canadian Field-Naturalist*. 67(2): 77; 1953.
- Lawrence, L. de K. A comparative life history study of four species of woodpeckers. *Ornithol. Monographs* No. 5. Lawrence, KS: American Ornithological Union; 1967. 156 p.
- Lea, R. B. A study of the nesting habits of the cedar wing. *Wilson Bulletin*. 54: 225-237; 1942.
- Lehner, P. N. Some observations on the ecology of mourning dove in New York. *New York Fish and Game Journal*. 12: 147-169; 1965.
- Lepthien, L. W.; Bock, C. E. Winter abundance patterns of North American kinglets. *Wilson Bulletin*. 483-485; 1976.
- Lewis, H. F. A nesting of the Philadelphia vireo. *Auk*. 38: 26-44, 185-202; 1921.
- Linehan, J. T. Nest records of Cerulean warblers in Delaware. *Wilson Bulletin*. 85: 482-483; 1973.
- Longcore, J. R.; Jones, R. E. Reproductive success of wood thrush in a Delaware wood lot. *Wilson Bulletin*. 81: 396-406; 1969.
- Lunk, W. A. The rough-winged swallow: A study of breeding biology in Michigan. Publ. No. 4. Cambridge, MA: Nuttall Ornithological Club; 1910. 155 p.
- MacArthur, R. H. Population ecology of some warblers of northeastern coniferous forests. *Ecology*. 39: 599-619; 1958.
- MacArthur, R. H. On the breeding distribution patterns of North American migrant birds. *Auk*. 76: 325; 1959.
- McGahan, J. Ecology of the golden eagle. *Auk*. 85: 1968.
- McGilvrey, F. B. A guide to wood duck production and requirements. U.S. Bureau of Sport Fisheries and Wildlife Research Publication No. 60: 1968.
- McLaren, M. A. Breeding biology of the boreal chickadee. *Wilson Bulletin*. 87: 344-354; 1975.
- MacQueen, P. M. Territory and song in the least flycatcher. *Wilson Bulletin*. 62: 194-205; 1950.
- Martin, A. C.; Zim, H. S.; Nelson, A. L. *American wildlife and plants*. New York: McGraw-Hill, Inc. 1951. 500 p.
- Martin, N. D. An analysis of bird populations in relation to forest succession. *Algonquin Provincial Park Ontario. Ecology*. 41: 126-140; 1960.
- Massachusetts Audubon Society. Bay state herons. *Massachusetts Audubon*. 17(3): 8-9; 1977.
- Matray, P. F. Broad-winged hawk nesting and ecology. *Auk*. 91: 307-324; 1974.
- Maxwell, G. R., II; Putnam, L. S. Incubation care of young and nest success of the common grackle (*Quiscalus quiscula*) in northern Ohio. *Auk*. 90: 349-359; 1972.

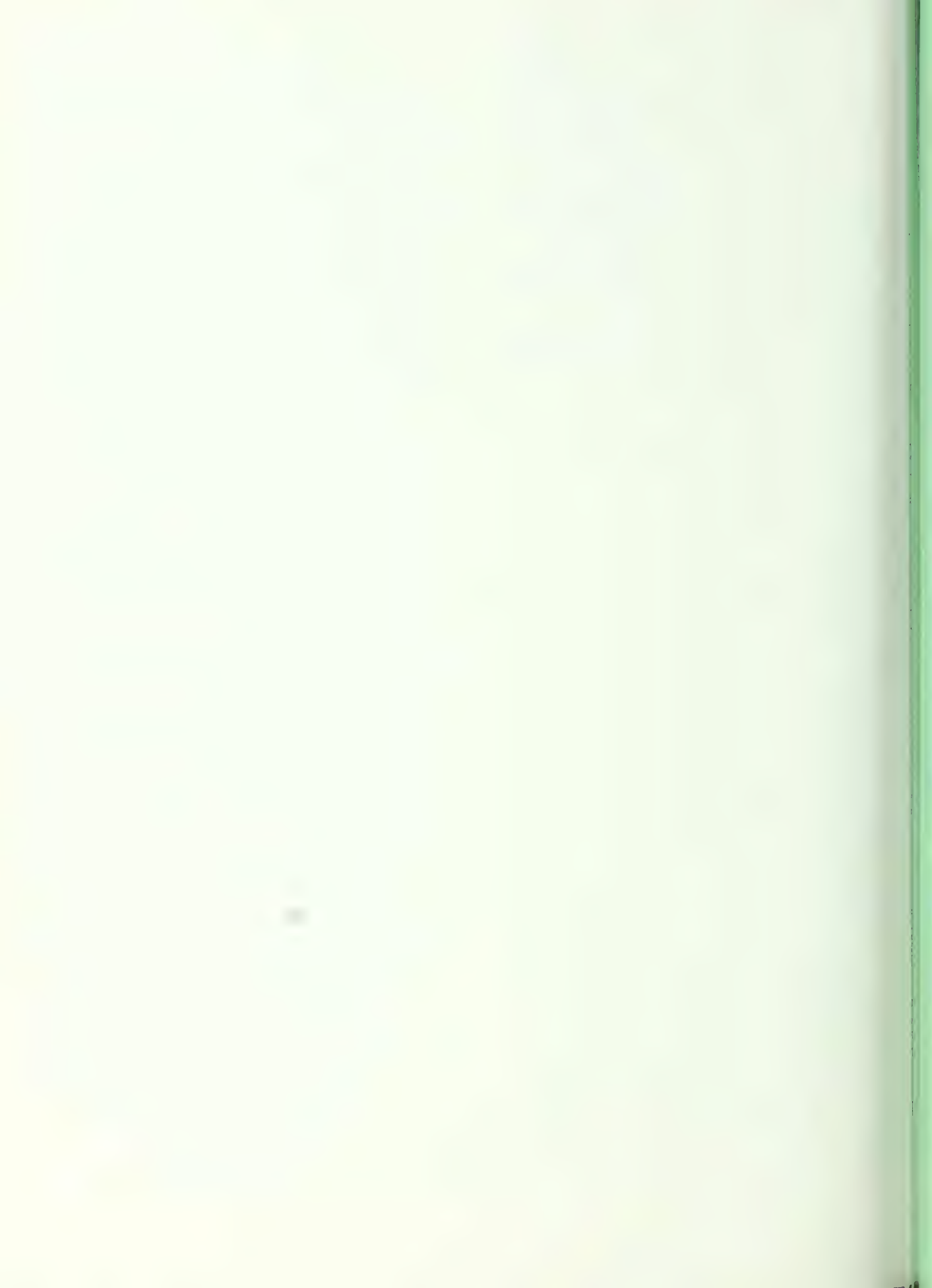
- well, G. R.; Nocilly, J. N.; Shearer, R. I. Observations at a cavity nest of the common grackle and an analysis of grackle nest sites. *Wilson Bulletin*. 88: 505-507; 1976.
- hew, W. W. The biology of the cliff swallow in California. *Condor*. 60: 7-37; 1958.
- nley, B. Natural history of the king rail. *North Am. Fauna No. 67*. Washington, DC: Bureau of Sport Fisheries and Wildlife; 1969. 108 p.
- dall, H. L. Nesting of the bay-breasted warbler. *Auk*. 54: 429-439; 1937.
- dall, H. L. Food of hawks and owls in Maine. *Journal of Wildlife Management*. 8: 198-208; 1944.
- dall, H. L. The ring-necked duck in the Northeast. Orono, ME: University of Maine Press; 1958. 317 p.
- dall, H. L.; Aldous, C. M. The ecology and management of the American woodcock. Orono, ME: Maine Cooperative Wildlife Research Unit; 1943. 201 p.
- r, H.; Nevius, R. R. Some observations on the nesting and development of the prothonotary warbler, *Protonotaria citrea*. *Migrant*. 14: 31-36; 1943.
- ener, H.; Michener, J. R. Mockingbirds, their territories and individualities. *Condor*. 37: 97-140; 1935.
- er, A. B. Cuckoos and caterpillars. *Bird-Lore*. 36: 301; 1934.
- er, A. H. Systematic revision and natural history of the American shrikes (*Lanius*). University of California Publication in Zoology. 38(2): 11-242; 1931.
- er, J. R.; Miller, J. T. Nesting of the spotted sandpiper at Detroit, Michigan. *Auk*. 65: 558-567; 1948.
- er, L. M.; Burger, J. Factors affecting nesting success of the glossy ibis. *Auk*. 95: 353-361; 1978.
- re, D. H. Habitat differences of Swainson's and hermit thrushes. *Wilson Bulletin*. 84: 206-208; 1972.
- re, D. H. Variables affecting the density and territory size of breeding spruce-wood warblers. *Ecology*. 57: 290-301; 1976.
- sy, H. S.; Handley, Co. O. The wild turkey in Virginia: Its status, life history and management. Richmond, VA: Virginia Commission Game and Inland Fisheries; 1943. 281 p.
- uley, H. A study of the home life of the northern crested flycatcher. *Auk*. 51: 207-216; 1934.
- ord, R. E. The breeding biology of the Acadian flycatcher. University of Michigan Museum of Zoology Miscellaneous Publication. 125: 1-50; 1964.
- n, J. A. Studies of waterfowl in British Columbia: Pintail. *Canadian Journal of Research*. 22: 60-86; 1944.
- n, J. A. Studies of waterfowl in British Columbia: Baldpate. *Canadian Journal of Research, Series D*. 7: 289-307; 1949.
- ny, B. G., Jr.; Gill, F. B. Behavioral interactions of blue-winged and golden-winged warblers. *Wilson Bulletin*. 88: 231-254; 1976.
- Murray, J. J. Nesting habits of the raven in Rockbridge County, Virginia. *Raven*. 20: 40-43; 1940.
- Nagy, A. C. Population density of sparrow hawks in eastern Pennsylvania. *Wilson Bulletin*. 75: 93; 1963.
- Newman, D. L. A nesting of the Acadian flycatcher. *Wilson Bulletin*. 70: 130-144; 1958.
- Nice, M. M. A study of a nesting of black-throated blue warblers. *Auk*. 47: 338-345; 1930.
- Nice, M. M. Observations on the nesting of the blue-gray gnatcatcher. *Condor*. 34: 18-22; 1932.
- Nice, M. M. Studies in the life history of the song sparrow. I. A population study of the song sparrow. *Transactions of the Linnean Society of New York*. 4: 1-247; 1937.
- Nice, M. M. Studies in the life history of the song sparrow. II. *Transactions of the Linnean Society of New York*. 6: 1-328; 1943.
- Nice, M. M.; Thomas, R. H. A nesting of the Carolina wren. *Wilson Bulletin*. 60: 139-158; 1948.
- Nicholls, T. H.; Warner, D. W. Barred owl habitat use as determined by radiotelemetry. *Journal of Wildlife Management*. 36: 213-224; 1972.
- Nickell, W. P. Observations on the nesting of the killdeer. *Wilson Bulletin*. 55: 23-28; 1943.
- Nickell, W. P. Studies of habitats, locations and structural materials of nests of the robin. *Jack-Pine Warbler*. 22(2): 48-64; 1944.
- Nickell, W. P. Studies of habitats, territory, and nests of the eastern goldfinch. *Auk*. 68: 447-470; 1951.
- Nickell, W. P. Habitats, territory and nesting of the catbird. *American Midland Naturalist*. 73: 433-478; 1965.
- Noble, G. K.; Wurm, M.; Schmidt, A. Social behavior of the black-crowned night heron. *Auk*. 55: 7-40; 1938.
- Nolan, V., Jr. Breeding behavior of the Bell vireo in southern Indiana. *Condor*. 62: 225-244; 1960.
- Nolan, V., Jr. The ecology and behavior of the prairie warbler, *Dendroica discolor*. *American Ornithologists' Union Monograph No. 26*. 595 p. 1978.
- Odum, E. P. Annual cycle of the black-capped chickadee. *Auk*. 58: 314-333, 518-535; 1941.
- Odum, E. P. Annual cycle of the black-capped chickadee. *Auk*. 59: 499-531; 1942.
- Odum, E. P.; Johnston, D. E. The house wren breeding in Georgia. *Auk*. 68: 357-366; 1951.
- Odum, E. P.; Kuenzler, E. J. Measurement of territory and home range size in birds. *Auk*. 72: 128-137; 1955.
- Odum, R. R. Sora (*Porzana carolina*). In: Sanderson, Glen C., ed. *Management of migratory shore and upland game birds in North America*. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 57-65.
- Ogden, J. C. Effects of bald eagle territoriality on nesting ospreys. *Wilson Bulletin*. 87: 496-505; 1975.
- Olson, S.; Marshall, W. The common loon in Minnesota. *Occas. Pap. No. 5*. St. Paul, MN: University of Minnesota; 1952. 77 p.

- Orians, G. H. The ecology of blackbird (*Agelaius*) social systems. *Ecological Monographs*. 31: 285-312; 1961.
- Orians, G. H.; Kuhlman, F. Red-tailed hawk and horned owl populations in Wisconsin. *Condor*. 58: 371-385; 1956.
- Owen, R. B., Jr. American woodcock (*Philophela minor*). In: Sanderson, Glen C., ed. Management of migratory shore and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies; 1977: 150-186.
- Palmer, R. S., ed. Handbook of North American birds. Vol. I. Loons through flamingos. New Haven, CT: Yale University Press; 1962. 567 p.
- Palmer, R. S., ed. Handbook of North American birds. Vols. 2 and 3. Waterfowl. New Haven, CT: Yale University Press; 1976. 600 p.
- Parks, G. H.; Parks, H. C. Some notes on a trip to an evening grosbeak nesting area. *Bird-Banding*. 34: 22-30; 1963.
- Parmalee, D. F. Notes on the breeding of certain ducks and mergansers in Dickenson County, Michigan. *Jack-Pine Warbler*. 32: 110-118; 1954.
- Payne, R. B. Clutch size and numbers of eggs laid by brown-headed cowbirds. *Condor*. 67: 44-60; 1965.
- Paynter, R. A., Jr. Interrelation between clutch-size, brood-size, pre fledging survival, and weight in Kent Island tree swallows. *Bird-Banding*. 25(2): 35-58; 1954.
- Peakall, D. B. The eastern bluebird: its breeding season, clutch size, and nesting success. *Living Bird*. 9: 239-255; 1970.
- Petersen, A. J. The breeding cycle in the bank swallow. *Wilson Bulletin*. 67: 235-286; 1955.
- Petersen, A.; Young, H. A nesting study of the bronzed grackle. *Auk*. 67: 466-476; 1950.
- Pickens, A. L. Notes on nesting ruby-throated hummingbirds. *Wilson Bulletin*. 48: 80-85; 1936.
- Pickwell, G. B. The prairie horned lark. *Transactions of the Academy of Science of St. Louis*. 27: 1-153; 1931.
- Pinkowski, B. C. Foraging behavior of the eastern bluebird. *Wilson Bulletin*. 89: 414; 1977.
- Pitelka, F. A. High population of breeding birds within an artificial habitat. *Condor*. 44: 172-174; 1942.
- Platt, J. B. Sharp-shinned hawk nesting and nest site selection in Utah. *Condor*. 78: 102; 1976.
- Post, W.; Enders, F. Notes on a salt marsh Virginia rail population. *Kingbird*. 20: 61-67; 1970.
- Poston, H. J. Relationships between the shoveler and its breeding habitat at Strathmore, Alberta. In: Saskatoon Wetlands Seminar, Canadian Wildlife Service Report Series No. 6: 132-137; 1969.
- Pough, R. H. Audubon bird guide: Eastern land birds. New York: Doubleday and Co., Inc.; 1949. 312 p.
- Pough, R. H. Audubon water bird guide. New York: Doubleday and Co., Inc.; 1951. 352 p.
- Pratt, H. M. Breeding biology of great blue herons and common egrets in central California. *Condor*. 72: 407-416; 1970.
- Preble, N. A. The nesting habits of the yellow-bellied cuckoo. *American Midland Naturalist*. 57: 414-482; 1957.
- Prescott, K. W. The scarlet tanager (*Piranga olivacea*). New Jersey State Museum Investigations. 2: 1-11; 1965.
- Prince, H. H. Nest sites used by wood ducks and common goldeneyes in New Brunswick. *Journal of Wildlife Management*. 32: 489-500; 1968.
- Putnam, L. S. The life history of the cedar waxwing. *Wilson Bulletin*. 61: 141-182; 1949.
- Randall, P. E. Seasonal food habits of the marsh hawk in Pennsylvania. *Wilson Bulletin*. 52: 165-172; 1940.
- Randle, W.; Austing, R. Ecological notes on long-eared and saw-whet owls in southwestern Ohio. *Ecology*. 33: 422-426; 1952.
- Raynor, G. S. The nesting habits of the whip-poorwill. *Bird-Banding*. 12: 98-104; 1941.
- Reller, A. W. Aspects of behavioral ecology of black-headed and red-bellied woodpeckers. *American Midland Naturalist*. 88(2): 270-290; 1972.
- Ridgeway, R. Bird-life in southern Illinois. *Bird-Banding*. 17(2): 91-103; 1915.
- Robbins, C. S.; Bruun, B.; Zim, H. S. Birds of North America. New York: Golden Press: 1966. 340 p.
- Robins, J. D. A study of Henslow's sparrow in Michigan. *Wilson Bulletin*. 83: 39-48; 1971.
- Rogers, T. L. Behavior of the pine siskin. *Condor*. 35: 143-149; 1937.
- Roest, A. I. Notes on the American sparrow hawk. *Wilson Bulletin*. 74: 1-19; 1957.
- Root, R. B. The niche exploitation pattern of the gray gnatcatcher. *Ecological Monographs*. 37: 317-350; 1967.
- Root, R. B. The behavior and reproductive success of the blue-gray gnatcatcher. *Condor*. 71: 16-31; 1969.
- Roseberry, J. L.; Klimstra, W. D. The nesting ecology and reproductive performance of the eastern meadowlark. *Wilson Bulletin*. 82: 243-267; 1970.
- Rosene, W. The bobwhite quail: Its life and management. New Brunswick, NJ: Rutgers University Press; 1969. 418 p.
- Rothstein, S. I. High nest density and non-random placement in the cedar waxwing. *Condor*. 73: 485; 1971.
- Rust, H. J. Migration and nesting of nighthawks in northern Idaho. *Condor*. 49: 177-188; 1963.
- Samuel, D. E. The breeding biology of barn and swallow in West Virginia. *Wilson Bulletin*. 83: 284-301; 1971.
- Sargent, T. D. Winter studies on the tree sparrow (*Zonotrichia arborea*). *Bird-Banding*. 30: 27-37; 1959.

- nders, A. A. The fearless white-eyed vireo. *Wilson Bulletin*. 27: 316-321; 1915.
- er, J. C.; Lagler, K. F. The eastern belted kingfisher (*Megaceryle alcyon alcyon*) in relation fish management. *Transactions American Fisheries Society* 1946, 76th Annual Meeting; 1946: 97-117.
- orger, A. W. The wild turkey: Its history and domestication. Norman, OK: University of Oklahoma Press; 1966. 625 p.
- rantz, F. G. Nest life of the eastern yellow warbler. *Auk*. 60: 367-387; 1943.
- , V. E.; Evans, K. E.; Patton, D. R.; Stone, C. P. Cavity-nesting birds of North American forests. *Agric. Handb.* 511. Washington, DC: U.S. Department of Agriculture; 1977. 112 p.
- don, W. G. The book of the American woodcock. Amherst, MA: University of Massachusetts Press; 1967. 227 p.
- t, H. L.; Drew, L. C. Observations concerning behavior, feeding and pellets of short-eared owls. *American Midland Naturalist*. 67: 424-433; 1962.
- t, L. L., Jr. The blue-winged and golden-winged warbler in New York. *Kingbird*. 12: 59-67; 1962.
- t, L. L. Habits and interactions of North American three-toed woodpeckers (*Picoides arcticus* and *Picoides tridactylus*). *American Museum Novitates* 2547: 1-42; 1974.
- art, H. H.; Dueser, R. D.; Anderson, S. H. Influence of habitat alterations on bird and small mammal populations. In: *Timber-wildlife Management Symposium Proceedings*. Occas. Pap. 3. Columbia, MO: Missouri Academy of Sci.; 1974: 92-96.
- erson, M. B., Jr. The prothonotary warbler in the Carolina Piedmont. *Chat*. 33(2): 31-37; 1969.
- erson, M. B., Jr. The saw-whet owl population of North Carolina's southern Great Balsam Mountains. *Chat*. 36: 39-47; 1972.
- er, F. J. Status of the osprey, bald eagle and golden eagle in the Adirondacks. *New York Fish and Game Journal*. 21(1): 18-31; 1974.
- holder, S.; Agren, G. Reproductive behavior of the common loon. *Wilson Bulletin*. 894: 296-308; 1974.
- ni, D. G.; Wilson, C. R.; Frost, H. H. The biology of the American kestrel in central Utah. *Southwest Naturalist*. 17(1): 73-83; 1972.
- ni, R. L. Some ecological notes on the grasshopper sparrow. *Wilson Bulletin*. 75: 159-165; 1963.
- ni, W. J. Communication and relationships in the genus *Tyrannus*. *Nuttall Ornithological Club Publication No. 6*: 1-250; 1966.
- oyr, D.; Bonney, C.; Robertson, W. B. Twelfth breeding bird census. *Deciduous flood-plain forest*. *Audubon Field Notes*. 2(6): 237; 1948.
- utern W. E. Nesting of the red-eyed vireo in the Douglas Lake region, Michigan. *Jack-Pine Warbler*. 36: 105-130, 185-207; 1958.
- Spencer, O. R. Nesting habits of the black-billed cuckoo. *Wilson Bulletin*. 55: 11-22; 1943.
- Sperry, C. C. Food habits of a group of shore birds: Woodcock, snipe, knot, dowitcher. *U.S. Biological Survey Wildlife Research Bulletin No. 1*: 1-37; 1940.
- Spofford, W. R. The breeding status of the golden eagle in the Appalachians. *American Birds*. 25: 3-7; 1971.
- Stegeman, L. C. Winter food of the short-eared owl in central New York. *American Midland Naturalist*. 57: 120-124; 1957.
- Stein, R. C. The behavioral, ecological and morphological characteristics of two populations of the alder flycatcher (*Empidonax traillii*). *New York State Museum and Science Service Bulletin*. 371: 1-63; 1958.
- Stenger, J.; Falls, J. B. The utilized territory of the overbird. *Wilson Bulletin*. 71: 125-140; 1959.
- Stevens, C. E. Notes on summer birds in the Virginia mountains 1970-1975. *Raven*. 47(2): 35-40; 1976.
- Stewart, P. A. Dispersed breeding behavior, and longevity of banded barn owls in North America. *Auk*. 69: 227-245; 1952.
- Stewart, R. E. Ecology of a nesting red-shouldered hawk population. *Wilson Bulletin*. 61: 26-35; 1949.
- Stewart, R. E. A life history of the yellowthroat. *Wilson Bulletin*. 65: 99-115; 1953.
- Stewart, R. E. Waterfowl populations in the upper Chesapeake region. *Spec. Sci. Rep. Wildl. No. 65*. Washington, DC: U.S. Fish and Wildlife Service; 1962: 1-208.
- Stewart, R. E.; Kantrud, H. A. Population estimates of breeding birds in North Dakota. *Auk*. 89: 766-788; 1972.
- Stewart, R. E.; Robbins, C. S. Birds of Maryland and the District of Columbia. *North American Fauna No. 62*. Washington, DC: U.S. Fish and Wildlife Service; 1958. 401 p.
- Stewart, R. M. Breeding behavior and life history of the Wilson's warbler. *Wilson Bulletin*. 85: 21-30; 1973.
- Stobo, W. T.; McLaren, I. A. The Ipswich sparrow. *Halifax, NS: Nova Scotia Institute of Science*; 1975. 105 p.
- Stockard, C. R. Nesting habits of birds in Mississippi. *Auk*. 22: 146-158; 1905.
- Stoddard, H. L. The bobwhite quail: Its habits, preservation and increase. *New York: C. Scribner's and Sons*; 1931. 559 p.
- Stokes, A. W. Breeding behavior of the goldfinch. *Wilson Bulletin*. 62: 107-127; 1950.
- Stokes, A. W. Pelee Island pheasants. In: Allen, Durward L., ed. *Pheasants of North America*. Washington, DC: Wildlife Management Institute; 1956: 357-387.

- Stotts, V. The black duck (*Anas rubripes*) in the upper Chesapeake Bay. Proceedings 10th annual conference, Southeastern Association of Game and Fish Commission; 234-242; 1957.
- Strohmeyer, D.L. Common gallinule (*Gallinula chloropus*). In: Sanderson, Glen, C., ed. Management of migratory and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies; 1977. 358 p.
- Studholme, A. T.; Benson, D. The pheasant in the north-eastern states. In: Allen, Durward L., ed. Pheasants of North America. Washington, DC: Wildlife Management Institute; 1956. 490 p.
- Sturm, L. A study of the nesting activities of the American redstart. Auk. 62: 189-206; 1945.
- Summers-Smith, D. Nest-site selection, pair formation, and territory in the house-sparrow (*Passer domesticus*). Ibis. 100: 190-203; 1958.
- Sutton, G. M. Flocking, mating and nest-building habits of the prairie horned lark. Wilson Bulletin. 39: 131-141; 1927.
- Sutton, G. M. Birds of Pymatuning Swamp and Conneaut Lake, Crawford County, Pennsylvania. Annual Carnegie Museum. 18: 19-239; 1928.
- Sutton, G. M. The nesting fringillids of the Edwin S. George Reserve, southeastern Michigan (parts 6 and 7). Jack-Pine Warbler. 38: 46-65, 125-139; 1960.
- Svoboda, F. J.; Gullion, G. W. Preferential use of aspen by ruffed grouse in northern Minnesota. Journal of Wildlife Management. 36: 1166-1180; 1972.
- Tanner, J. T. The ivory-billed woodpecker. New York: Dover Publications, Inc.; 1942. 111 p.
- Tanner, W. D., Jr.; Hendrickson, G. O. Ecology of the sora in Clay County, Iowa. Iowa Bird Life. 26(4): 78-81; 1956.
- Terres, J. K. The Audubon encyclopedia of North American birds. New York: Alfred A. Knopf; 1982. 1109 p.
- Terrill, L. M. Nesting of the saw-whet owl in the Montreal District. Auk. 48: 169-174; 1931.
- Thomas, J. W.; Anderson, R.; Maser, C.; Bull, E. Snags. In: Thomas, J. W., ed. Wildlife habitats in managed forests—the Blue Mountains of Oregon and Washington. Agric. Handb. 553. Washington, DC: U.S. Department of Agriculture; 1979. 512 p.
- Thomas, R. H. A study of eastern bluebirds in Arkansas. Wilson Bulletin. 58: 143-183; 1946.
- Thompson, C. F.; Nolan, V., Jr. Population biology of the yellow-breasted chat (*Icteria virens* L.) in southern Indiana. Ecological Monographs. 43: 145-171; 1973.
- Todd, W. E. C. Birds of western Pennsylvania. Pittsburgh, PA: University of Pittsburgh Press; 1940. 710 p.
- Tompka, F. S. Territorial behavior: The main controlling factor of a local song sparrow population. Auk. 79: 687-697; 1962.
- Trautman, M. B. The Birds of Buckeye Lake, Ohio. University of Michigan, Miscellaneous Publications, Museum of Zoology. 44: 1-466; 1940.
- Tuck, L. M. The snipes: A study of the genus *Capo*. Canadian Wildlife Service Monographs. 5: 1-14; 1972.
- Twining, H. Life history and management of the red-necked pheasant in California. Pittman-Robertson Quartly. 6: 145-146; 1946.
- Tyrrell, W. B. A study of the northern raven. Auk. 67: 7; 1945.
- Uhlig, H. G. Resurvey of flock distribution of the wild turkey: West Virginia. Pittman-Robertson Quartly. 10(3): 371-372; 1950.
- Uhlig, H. G.; Bailey, R. W. Factors influencing the distribution and abundance of the wild turkey in West Virginia. Journal of Wildlife Management. 16: 32; 1952.
- U.S. Department of Agriculture, Forest Service. Bald eagle habitat management guidelines. California region. San Francisco: USDA Forest Service; 1977. 60 p.
- Van Camp, L. F.; Henny, C. J. The screech owl: Its history and population ecology in northern California. North American Fauna No. 71. Washington, DC: U.S. Fish and Wildlife Service; 1975. 65 p.
- Van Tyne, J. Home range and duration of family ties in the tufted titmouse. Wilson Bulletin. 60: 121; 1948.
- Van Velzen, W. T. Fortieth breeding bird census. American birds. 31: 24-93; 1977.
- Vermeer, K. Some aspects of the nesting requirements of common loons in Alberta. Wilson Bulletin. 85: 435; 1973.
- Verner, J. Breeding biology of the long-billed marsh wren. Condor. 67: 6-30; 1965.
- Vesall, D. B. Notes on nesting habits of the American bittern. Auk. 52: 207-208; 1940.
- Walkinshaw, L. H. Studies of the short-billed marsh wren (*Cistothorus stellaris*) in Michigan. Auk. 52: 362-369; 1935.
- Walkinshaw, L. H. The Virginia rail in Michigan. Auk. 54: 664-475; 1937.
- Walkinshaw, L. H. Life history studies of the eastern goldfinch. Part I. Jack-Pine Warbler. 16: 3-11, 15; 1938a.
- Walkinshaw, L. H. Nesting studies of the prothonotary warbler. Bird-Banding. 9: 32-46; 1938b.
- Walkinshaw, L. H. Life History studies of the eastern goldfinch. Part II. Jack-Pine Warbler. 17: 3-11; 1939a.
- Walkinshaw, L. H. Nesting of the field sparrow and survival of the young. Bird-banding. 10: 107-111; 1939b.
- Walkinshaw, L. H. Summer life of the sora rail. Auk. 55: 153-168; 1940.
- Walkinshaw, L. H. The eastern chipping sparrow in Michigan. Wilson Bulletin. 56: 193-205; 1944.

- Elkshaw, L. H. Life history of the prothonotary warbler. *Wilson Bulletin*. 65: 152-168; 1953.
- Elkshaw, L. H. Yellow-bellied flycatcher nesting in Michigan. *Auk*. 74: 293-304; 1957.
- Elkshaw, L. H. Summer biology of Traill's flycatcher. *Wilson Bulletin*. 78: 31-46; 1966.
- Elkshaw, L. H.; Wolf, A. M. Distribution of the palm warbler and its status in Michigan. *Wilson Bulletin*. 69: 338-351; 1957.
- Ellace, G. J. Bicknell's thrush: Its taxonomy, distribution and life history. *Proceedings Boston Society Natural History*. 41: 211-402; 1939.
- Ellace, J. G. The barn owl in Michigan, its distribution, natural history and food habits. *Michigan State College of Agriculture Experiment Technical Bulletin No. 208*; 1948.
- Ever, F. G. Studies in the life history of the wood thrush. *Bird-Banding*. 10: 16-23; 1939.
- Ever, R. L. Growth and development of English sparrows. *Wilson Bulletin*. 54: 183-191; 1942.
- Ever, R. L.; West, F. H. Notes on the breeding of the pine siskin. *Auk*. 60: 492-504; 1943.
- Foster, C. G. Fall foods of soras from two habitats in Connecticut. *Journal of Wildlife Management*. 28: 163-165; 1964.
- Fuller, M. W. Breeding biology of the least bittern. *Wilson Bulletin*. 73: 11-35; 1961.
- Fuller, M. W.; Fredrickson, L. H. Avian ecology of a managed glacial marsh. *Living Bird*. 12: 269-291; 1973.
- Gish, D. Savannah sparrow breeding and territoriality on a Nova Scotia dune beach. *Auk*. 92: 235-251; 1975.
- Grier, W. A. The natural history of the long-billed marsh wren. *Wilson Bulletin*. 47: 3-34; 1935.
- Heschkul, D. F.; McMahon, E.; Leitschuh, M. Some effects of human activities on the great blue heron in Oregon. *Wilson Bulletin*. 88: 660-662; 1976.
- Monroe, A. Birds of Puerto Rico. *Tech. Bull.* 326. Washington, DC: U.S. Department of Agriculture; 1916. 140 p.
- Re, H. C. The eastern belted kingfisher in the Maritime Provinces. *Bull.* 97. Ottawa, ON: Fisheries Research Board of Canada; 1953. 44 p.
- Re, M.; Harris, S. Winter occurrence, foods and habitat use of snipe in northwest California. *Journal of Wildlife Management*. 30: 23-34; 1966.
- Shible, C. L. Notes on the nesting habits of the tree swallow. *Auk*. 43: 247-248; 1926.
- Siens, J. A. An approach to the study of ecological relationships among grassland birds. *American Ornithologists' Union, Ornithological Monographs*. No. 8: 1-93; 1969.
- Siens, J. A. Interterritorial habitat variation in grasshopper and savannah sparrows. *Ecology*. 54: 877-884; 1973.
- Willard, D. E. The feeding ecology and behavior of five species of herons in southeastern New Jersey. *Condor*. 79: 462-470; 1977.
- Williams, B. Growth rate and nesting aspects for the glossy ibis in Virginia. *Raven*. 46(2): 35-51; 1975a.
- Williams, C. S.; Marshall, W. H. Duck nesting studies, Bear River Migratory Bird Refuge, Utah, 1937. *Journal of Wildlife Management*. 2: 29-48; 1938.
- Williams, J. B. Habitat utilization by four species of woodpeckers in a central Illinois woodland. *American Midland Naturalist*. 93(2): 354-367; 1975b.
- Williamson, P. Feeding ecology of the red-eyed vireo (*Vireo olivaceus*) and associated foliage-gleaning birds. *Ecological Monographs*. 41: 129-152; 1971.
- Williamson, P.; Gray, L. Foraging behavior of the starling (*Sturnus vulgaris*) in Maryland. *Condor*. 77: 84-89; 1975.
- Willoughby, E. J.; Kape, T. J. Breeding behavior of the American kestrel (sparrow hawk). *Living Bird*. 3: 75-96; 1964.
- Willson, M. F. Foraging behavior of some winter birds of deciduous woods. *Condor*. 72: 169-174; 1970.
- Wood, N. A. The birds of Michigan. University of Michigan Museum of Zoology Miscellaneous Publication No. 75: 1-559; 1951.
- Wood, R.; Gelston, W. L. Preliminary report: The mute swans of Michigan's Grand Traverse Bay region. Rep. 2683. Lansing, MI: Michigan Department of Natural Resources; 1972. 6 p.
- Woodgerd, W. Food habits of the golden eagle. *Journal of Wildlife Management*. 16: 457-459; 1952.
- Work, T. H.; Wool, A. J. The nest life of the turkey vulture. *Condor*. 44: 145-159; 1942.
- Yeager, L. E. Two woodpecker populations in relation to environmental change. *Condor*. 57: 148-153; 1955.
- Yeatter, R. E. The Hungarian Partridge in the Great Lakes Region. *Bull.* No. 5. Ann Arbor, MI: University of Michigan School of Forestry and Conservation; 1934. 92 p.
- Young, H. Territorial behavior of the eastern robin. *Proceedings of the Linnean Society of New York*. 58-62: 1-37; 1951.
- Young, H. Breeding behavior and nesting of the eastern robin. *American Midland Naturalist*. 53: 329-352; 1955.
- Zimmerman, J. L. Virginia rail (*Rallus limnicola*). In: Sanderson, Glen C., ed. Management of migratory shore and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies; 1977. 358 p.



Mammals

This section provides information on the life history, distribution, and habitat associations of terrestrial mammals in New England. Nomenclature follows the *Revised checklist of North American mammals north of Mexico, 1982* (Jones et al. 1982). This checklist is the standard reference used by the American Society of Mammalogists. Species are arranged in phylogenetic order.

We have included the mountain lion (*Felis concolor*), which many consider to be extirpated from the Northeastern United States and adjacent Canada; however, many unconfirmed sightings and one confirmed

track cast (R. Downing, personal communication) warrant its inclusion here. We have omitted the beach mouse (*Microtus breweri*) which only inhabits Muskeget Island, Massachusetts.

The relationships of New England mammals to their habitats are not understood as well as those of birds. For some species, life history and distribution data are lacking, particularly for bats and shrews. For such species, this compilation must be regarded as a starting point. From a habitat structure or classification standpoint, mammals have not been studied as thoroughly as have birds.

Species List

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Soricidae	
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Water Shrew (<i>Sorex palustris</i>)	...402
Smoky Shrew (<i>Sorex fumeus</i>)	...403
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Pygmy Shrew (<i>Sorex hoyi</i>)	...405
Short-tailed Shrew (<i>Blarina brevicauda</i>)	...406
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Indiana Myotis (<i>Myotis sodalis</i>)	...413
Small-footed Myotis (<i>Myotis leibii</i>)	...414
Silver-haired Bat	
(<i>Lasionycteris noctivagans</i>)	...415
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Big Brown Bat (<i>Eptesicus fuscus</i>)	...417
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<i>transitionalis</i>)	...421
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European Hare (<i>Lepus capensis</i>)	...423
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Gray Squirrel (<i>Sciurus carolinensis</i>)	...426
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Southern Flying Squirrel	
(<i>Glaucomys volans</i>)	...428
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<i>sabrinus</i>)	...429
Castoridae	
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Deer Mouse (<i>Peromyscus maniculatus</i>)	...431
White-footed Mouse (<i>Peromyscus leucopus</i>)	...432
Southern Red-backed Vole (<i>Clethrionomys</i>	
<i>gapperi</i>)	...433
Meadow Vole (<i>Microtus pennsylvanicus</i>)	...434
Rock Vole (<i>Microtus chrotorrhinus</i>)	...435
Woodland Vole (<i>Microtus pinetorum</i>)	...436
Muskrat (<i>Ondatra zibethicus</i>)	...437
Southern Bog Lemming (<i>Synaptomys</i>	
<i>cooperi</i>)	...438
Northern Bog Lemming (<i>Synaptomys</i>	
<i>borealis</i>)	...439
Muridae	
Norway Rat (<i>Rattus norvegicus</i>)	...440
House Mouse (<i>Mus musculus</i>)	...441
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Meadow Jumping Mouse (<i>Zapus hudsonius</i>)	...442
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Erethizontidae	
Porcupine (<i>Erethizon dorsatum</i>)	...444
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Red Fox (<i>Vulpes vulpes</i>)	...446
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Ursidae	
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Long-tailed Weasel (<i>Mustela frenata</i>)	...453
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Striped Skunk (<i>Mephitis mephitis</i>)	...455
River Otter (<i>Lutra canadensis</i>)	...456
Felidae	
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Lynx (<i>Felis lynx</i>)	...458
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Artiodactyla	
Cervidae	
White-tailed Deer (<i>Odocoileus virginianus</i>)	...460
Moose (<i>Alces alces</i>)	...461

FORESTED

Local occurrence	SPECIES	Special habitat needs
	Virginia Opossum <i>Didelphis virginiana</i>	Log or tree cavity
	Masked Shrew <i>Sorex cinereus</i>	Damp woodlands, ground cover.
	Water Shrew <i>Sorex palustris</i>	Herbaceous cover, cold-water wetlands.
	Smoky Shrew <i>Sorex fumeus</i>	Loose damp leaf litter
	Long-tailed Shrew <i>Sorex dispar</i>	Rocky, wooded sites.
	Pygmy Shrew <i>Sorex hoyi</i>	Moist leaf mold near water.
	Northern Short-tailed Shrew <i>Blarina brevicauda</i>	Low vegetation, damp, loose leaf litter.
	Least Shrew <i>Cryptotis parva</i>	Loose soil.
	Hairy-tailed Mole <i>Parascalops breweri</i>	Loose, moist, well-drained soil.
	Eastern Mole <i>Scalopus aquaticus</i>	Soft, moist soils containing earthworms
	Star-nosed Mole <i>Condylura cristata</i>	Wet muck, humus.

SPECIES	Special habitat needs	Local occurrence	Eastern hemlock											
			S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
Little Brown Myotis <i>Myotis lucifugus</i>	Females: dark, warm sites for maternity colonies. Forest openings for feeding.													
	Caves, mine shafts with temperatures near 40°F; high relative humidity and calm air.													
	Caves for hibernation: cool, stable temperature of 40° to 46°F thru winter.													
		▲												
Keen's Myotis <i>Myotis keenii</i>														
Indiana Myotis <i>Myotis sodalis</i>														
Small-footed Myotis <i>Myotis leibii</i>														
Silver-haired Bat <i>Lasionycteris noctivagans</i>	Dead trees with loose bark or cavities; streams													
Eastern Pipistrelle <i>Pipistrellus subflavus</i>	Warm, draft-free, damp sites for hibernation, open woods													
Big Brown Bat <i>Eptesicus tuscus</i>	Cold, dry areas of caves or buildings for hibernation.													
Red Bat <i>Lasiurus borealis</i>	Deciduous trees on forest edges for roosting													
Hoary bat <i>Lasiurus cinereus</i>	Edges of coniferous forests													
Eastern Cottontail <i>Sylvilagus floridanus</i>	Brush piles, stone walls, dens or burrows; herbaceous and shrubby cover													
New England Cottontail <i>Sylvilagus transitionalis</i>	Young woodlands with thick cover													
Seasonal use			B	BF	W	WF	B	BF	W	WF	B	BF	W	WF
Northern red oak														
Red maple														
Northern hardwoods														
Paper birch														
Aspen														

*See matrix for nonforested types

SPECIES	Special habitat needs	Local occurrence	Seasonal use	Aspen	Paper birch	Northern hardwoods	Red maple	Northern red oak	White pine— Northern red oak— Red maple	Balsam fir	Eastern white pine	Red spruce - Balsam fir	Red spruce	Eastern hemlock
Snowshoe Hare <i>Lepus americanus</i>	Dense brushy or softwood cover.		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
European Hare <i>Lepus capensis</i>	Fields, meadows		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Eastern Chipmunk <i>Tamias striatus</i>	Forest edge or shrub cover, elevated perches, logs.		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Woodchuck <i>Marmota monax</i>	Open land.		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Gray Squirrel <i>Sciurus carolinensis</i>	Tall trees for dens or leafnests		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Red Squirrel <i>Tamiasciurus hudsonicus</i>	Woodlands with mature trees, conifers preferred.		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Southern Flying Squirrel <i>Glaucomys volans</i>	Mature woodland with cavity trees; favors cavities with entrance diameters of 1.6 to 2 in		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Northern Flying Squirrel <i>Glaucomys sabrinus</i>	Mature trees; cavities for winter dens; arboreal lichens.		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Beaver <i>Castor canadensis</i>	Woodland streams, lack of disturbance.		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
Deer Mouse <i>Peromyscus maniculatus</i>	Northern hardwoods or northern coniferous forests		B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
White-Footed Mouse <i>Peromyscus leucopus</i>			B BF W WF	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L

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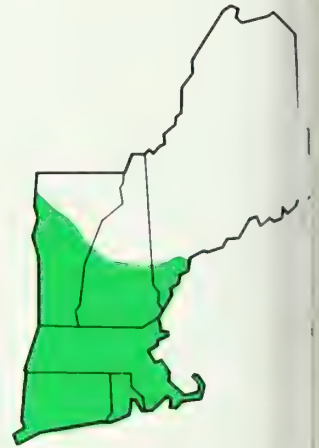
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SPECIES	Special habitat needs	Seasonal use	Terrestrial	Wetland Deep Water	Other
Local occurrence			Upland field Forb Grass Cultivated Shrub/old field Pasture Savanna Orchard Krummholz Alpine	Palustrine Sedge meadow Shallow marsh Deep marsh Shrub swamp Bog Pond Lake Stream River Riparian Estuary/salt marsh Coastal beach/rocks Bay, ocean	Stable bank Ledge, cliff Cave Structure, building Derelict building, debris
Snowshoe Hare <i>Lepus americanus</i>	Dense brushy or softwood cover	B BF W WF			
European Hare <i>Lepus capensis</i>	Fields, meadows	B BF W WF			
Eastern Chipmunk <i>Tamias striatus</i>	Tree or shrub cover, elevated perches, logs	B BF W WF			
Woodchuck <i>Marmota monax</i>	Open or semi-open country	B BF W WF			
Gray Squirrel <i>Sciurus carolinensis</i>	Tall trees for dens or leafnests	B BF W WF			
Red Squirrel <i>Tamiasciurus hudsonicus</i>	Woodlands with mature trees, conifers preferred	B BF W WF			
Southern Flying Squirrel <i>Glaucomys volans</i>	Mature woodland with cavity trees, favors cavities with entrance diameters of 1.6 to 2 in.	B BF W WF			
Northern Flying Squirrel <i>Glaucomys sabrinus</i>	Mature trees, cavities for winter dens, arboreal lichens	B BF W WF			
Beaver <i>Castor canadensis</i>	Woodland streams, lack of disturbance	B BF W WF			
Deer Mouse <i>Peromyscus maniculatus</i>	Northern hardwoods or northern coniferous forests	B BF W WF			
White-footed Mouse <i>Peromyscus leucopus</i>		B BF W WF			

[illegible]

Virginia Opossum

(*Didelphis virginiana*)



RANGE: Throughout the Eastern United States except n. New England. Also occurs along the West Coast as a result of transplants and in parts of Central America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Dry to wet wooded areas; commonly found in wet woods near rivers and swamps, less often in wooded uplands or cultivated fields. Common near human habitation where they are attracted to garbage.

SPECIAL HABITAT REQUIREMENTS: Den—usually in abandoned burrow, tree cavity, hollow log, or brush pile; water (Llewellyn and Dale 1964).

REPRODUCTION: Age at sexual maturity: 8 to 12 months. Breeding period: Late January to early July, New York (Hamilton 1958). Gestation period: 13 days (Lay 1942). Young born: February to July in extremely undeveloped stage and remain in female's pouch for 60 days. Litter size: 5 to 13, average 8. Litters per year: 1 per year in north, 2 or 3 per year in south (Walker 1975:24).

HOME RANGE: Not territorial; separate home ranges not maintained. Average minimum range was 11.5 acres (4.7 ha). Range 0.33 to 58 acres (0.1 to 23.5 ha) for 29 opossums in East Texas (Lay 1942). 15 to 40 acres (6 to 16 ha) (Burt and Grossenheider 1976:1). Average minimum length of 25 elongate ranges in several habitats in Maryland was 0.6 mile (1 km) (Llewellyn and Dale 1964).

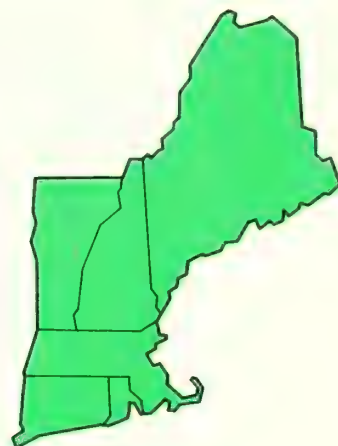
FOOD HABITS: Insects, worms, fruits, nuts, carrion, and garbage; almost any vegetable or animal food (Lay 1942). Also preys on voles, shrews, and moles (Hamilton 1951, Taube 1947).

COMMENTS: In winter, opossums become less active but do not hibernate (McManus 1971). Individuals in the north are often lacking ears and tails due to frostbite. Avoids predators by feigning death and voiding noxious odors (Francq 1969).

KEY REFERENCES: Hamilton 1958, Hartman 1953, Lay 1942, Llewellyn and Dale 1964, McManus 1974, Williams and Hendrickson 1950.

Masked Shrew

(*Sorex cinereus*)



RANGE: Throughout Canada and Alaska s. to North Carolina, New Mexico (mountains), and c. Washington.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Damp deciduous and coniferous woodlands, grasses, rocks, logs, or stumps for cover; bogs and other moist areas. Less often in open country with abundant moisture or in dry woods. Kirkland (1977b) found it in clearcuts in West Virginia.

ADDITIONAL HABITAT REQUIREMENTS: High humidity (moist areas) (Banfield 1974:9), ground cover (especially mosses, rotten logs, herbaceous vegetation).

REPRODUCTION: Age at sexual maturity: 20 to 26 weeks (Peterson 1961). Breeding period: Late April to late September or October (Banfield 1974:9). Gestation period: probably 18 days (Godin 1977:24, Peterson 1966:36). Young born: Late April to September or October. Litter size: 2 to 10, average 4.4 (Banfield 1974:9). Litters per year: Up to 3 may be produced in a single season.

HOME RANGE: About 0.10 acre (0.04 ha) (Banfield 1974:9).

POPULATION DENSITIES: Densities of up to 9 individuals per acre (22/ha) have been reported in favorable habitats (Banfield 1974:9).

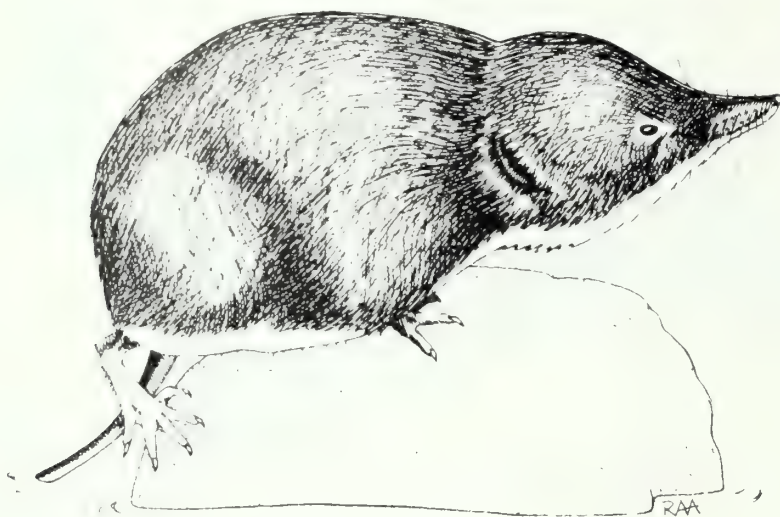
FOOD HABITS: Mainly insectivorous and carnivorous. Also consumes worms, spiders, snails, slugs, and small amounts of vegetable matter. Feeds among litter on forest floor.

COMMENTS: Young are independent when about 1 month old (Godin 1977:24). Nests in grass, or under logs, rocks, or brush. Active throughout winter.

KEY REFERENCES: Banfield 1974, Walker 1975, Wrigley et al. 1979.

Water Shrew

(*Sorex palustris*)



RANGE: Nova Scotia and s. Quebec w. to British Columbia, s. through New England, much of New York, Pennsylvania, and the s. Appalachians. Also occurs in the mountains of the West.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: Wet areas, especially grass-sedge marsh or shrub zones along ponds and streams in coniferous forest (Wrigley et al. 1979). Also at wooded shores with favorable cover in the form of crevices beneath boulders, tree roots, or overhanging banks.

SPECIAL HABITAT REQUIREMENTS: Herbaceous cover, body of cold water (bog, stream, lake, and so on).

REPRODUCTION: Age at sexual maturity: Possibly 9 months. Breeding period: Possibly February to August. Peak: Possibly March to July. Gestation period: Probably about 21 days (Conaway 1952). Young born: Probably March to August. Litter size: 4 to 8, average 6. Litters per year: Possibly 2 to 3 are produced each year by mature females (Banfield 1974:14).

HOME RANGE: 0.5 and 0.8 acres (0.2 and 0.3 ha) for two individuals live-trapped in Manitoba (Buckner and Ray 1968).

FOOD HABITS: Insectivorous—mainly eats larvae of aquatic insects. Also takes snails, flatworms, and small fish (Banfield 1974:14).

COMMENTS: Little is known about the habits of this species. Have been found more than 100 m from streams in mature northern hardwood stands in northern New Hampshire (D. Rudis, personal observation).

KEY REFERENCES: Banfield 1974, Conaway 1952, Wrigley et al. 1979.

Smoky Shrew

(*Sorex fumeus*)



RANGE: Maritime Provinces, s. Quebec and Ontario w. Lake Superior. Southern Maine s. through parts of s. New England, Ohio, Kentucky, and Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common uncommon.

HABITAT: Damp, boulder-strewn, upland woods (often beech or maple, birch and hemlock) with thick leafmold. Typically near streams with moss-covered banks (Burt and Grossenheider 1976:5, Godin 1977:27). Also uses early clearcuts in coniferous woodlands (Kirkland 1977b).

SPECIAL HABITAT REQUIREMENTS: Loose damp leaf litter—does not burrow, uses runways of other small mammals (Banfield 1974:16) in shady wooded areas (Peterson 196:38).

REPRODUCTION: Age at sexual maturity: Spring following first winter. Breeding period: Late March to early August (New York Godin 1977:27). Gestation period: About 20 days (Hamilton 1940). Young born: Mid-April through August (New York) (Hamilton 1940). Litters per year: Up to 3 (Hamilton 1940).

SAMPLE DENSITIES: Ranged from 5 to 50 individuals per hectare (12 to 123/ha) in late summer (Hamilton 1940).

FOOD HABITS: Mainly insectivorous (80 percent) but also eats earthworms, spiders, snails, salamanders, small mammals, and birds (Hamilton 1940:480).

COMMENTS: Usually nests beneath stump, rotten log or in tunnels dug by larger mammals (Banfield 1974:16, Godin 1977:27). Active throughout winter (Banfield 1974:16).

KEY REFERENCES: Banfield 1974, Godin 1977, Hamilton 1940.

Long-armed Shrew

(*Sorex dispar*)



RANGE: Central and w. Maine s. in the Appalachians to North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Undetermined—possibly rare.

HABITAT: Cold, damp coniferous forests, typically near moss-covered rocks and logs, which provide shady protective crevices, or wooded talus slopes (Connor 1960, Richmond and Grimm 1950). Also found in deciduous and mixed forest (Burt and Grossenheider 1976:b). Five individuals were found in a 1-year-old red spruce clear-cut in West Virginia (Kirkland et al. 1976). Others have been taken in road construction rubble (Conaway and Pfitzer 1952).

SPECIAL HABITAT REQUIREMENTS: Rocky, wooded sites.

REPRODUCTION: Age at sexual maturity: Less than 1 year. Breeding period: Possibly late April to August (Kirkland and Van Deusen 1979). Gestation period: Unknown. Young born: Probably May to August. Litter size: 5 reported (total of 4 records for litter size).

HOME RANGE: Unknown.

SAMPLE DENSITIES: 7 individuals were trapped on 1 acre (0.4 ha) of talus in Pennsylvania (Richmond and Grimm 1950).

FOOD HABITS: Mainly insectivorous. Also eats centipedes and spiders (Connor 1960, Richmond and Grimm 1950).

COMMENTS: Little is known about this shrew. Occasionally it is found in moderate numbers in favorable habitat and is known to be partly subterranean. Also called rock shrew.

KEY REFERENCES: Connor 1960, Godin 1977, Kirkland and Van Deusen 1979, Richmond and Grimm 1950.

Pygmy shrew

(*Sorex hoyi*)



RANGE: Gaspé Peninsula w. to s. Wisconsin, s. in the Appalachians to n. Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Generally thought to be rare, but may be fairly common.

HABITAT: Wet or mixed (wet-dry) habitat or less often in areas close to water. Found in damp litter especially in rotten stumps and logs in wooded areas. Prefers crevice openings in coniferous forests (Godin 1977:20), but tolerates a variety of habitat conditions (Wrigley et al. 1979). In New Hampshire, this species was more abundant in swamp hardwood than coniferous stands (Gill 1982).

ENVIRONMENTAL HABITAT REQUIREMENTS: Moist leafmold near water.

REPRODUCTION: Age at sexual maturity: Unknown. Breeding period: Unknown. Gestation period: Unknown. Young born: Unknown. Litter size: Unknown. Litters per year: May bear only 1.

DIET RANGE: Unknown.

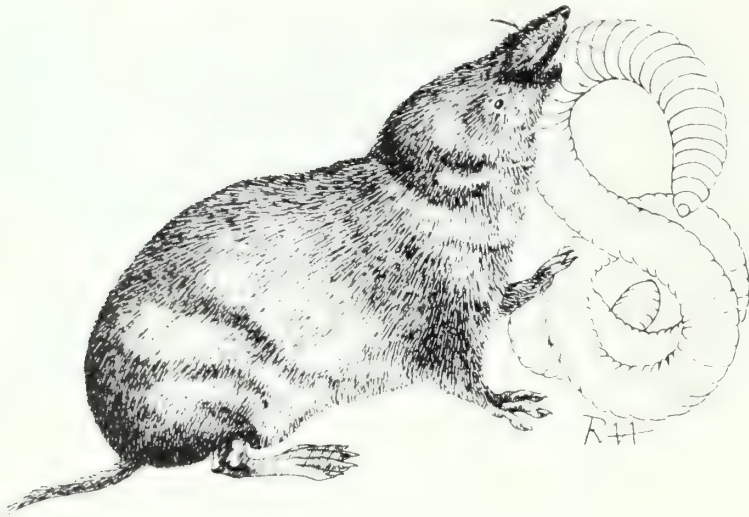
FOOD HABITS: Observed eating insects and flesh of small animals in captivity.

REMARKS: Life history is little known.

KEY REFERENCES: Godin 1977; Long 1972, 1974; Prince 1974; Spencer and Pettus 1966; Wrigley et al. 1979.

Short-tailed Shrew

(*Blarina brevicauda*)



RANGE: Nova Scotia w. to Saskatchewan, s. to East Texas and s. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Both timbered and fairly open habitats: deciduous, mixed, and less often coniferous forests with moist loose humus; especially common along banks of streams and in meadows with tall rank grasses or sedges, brush piles, and stone walls. Avoids dry, warm sites (Getz 1961a, Pruitt 1959). Favored grass-sedge marsh and willow-alder shrub zone in Manitoba (Wrigley et al. 1979).

SPECIAL HABITAT REQUIREMENTS: Low vegetation, loose leaf litter, high humidity.

REPRODUCTION: Age at sexual maturity: Early females may mature in 6 weeks, but probably do not breed until a year after their birth. Breeding period: March to September. Gestation period: 21 to 22 days. Young born: April to September. Litter size: 3 to 10, average 4.5 (Banfield 1974:23). Litters per year: 2 to 3.

HOME RANGE: 1.0 to 1.25 acres (0.40 to 0.51 ha) (Banfield 1974:22), 0.5 to 1.0 acre (0.2 to 0.4 ha) (Burt and Grossheider 1976:16).

SAMPLE DENSITIES: Densities of up to 48 individuals per acre (119/ha) have been reported in good habitats (Banfield 1974:22).

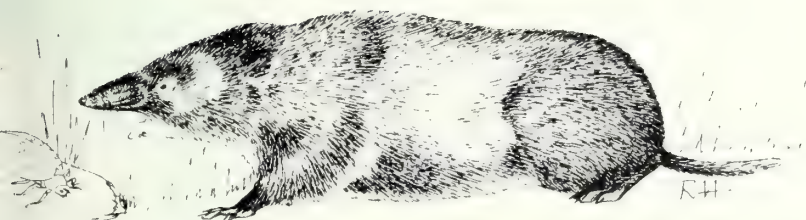
FOOD HABITS: Mainly insects, plants, worms, sowbugs, snails, small vertebrates, centipedes and millipedes, and other invertebrates (Banfield 1974:23).

COMMENTS: Active day and night throughout the year. More fossorial than other shrews; digs own tunnels and uses burrows of other vertebrate species, especially voles.

KEY REFERENCES: Banfield 1974; Blair 1940a, 1941; Blair 1940; Hamilton 1931a; Wrigley et al. 1979.

Least Shrew

(*Blarina hyemalis*)



RANGE: Southwestern Connecticut w. through c. New York to South Dakota, s. through e. Texas and Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Undetermined—may be fairly common. Seldom caught in traps, but remains are often found in owl pellets (Banfield 1974:25).

HABITAT: Open grassy areas with or without scattered shrubs, salt marshes, woodland edges (Banfield 1974:25, Godin 1977:34).

DIETARY HABITAT REQUIREMENTS: Loose soils for tunnels (it uses runways of larger mice and shrews).

REPRODUCTION: Age at sexual maturity: About 40 days (Godin 1977:35). Breeding period: Early March to early November (at northern edge of range) (Hamilton 1944). Gestation period: About 15 days (Godin 1977:35). Young born: Late March to late November. Litter size: 3 to 6 (average 4 or 5) (Godin 1977:35). Litters per year: Usually 2 to 3.

WINTER RANGE: Unknown.

FOOD HABITS: Insects, mollusks, amphibians, lizards, birds, mammals, and vegetable matter (Hamilton 1944).

COMMENTS: Rarely nests in burrows. More often uses hollows under stones, logs, or stumps. Highly social—31 individuals were found in one winter nest (Burt and Grossenheider 1976:15).

KEY REFERENCES: Conaway 1952, Hamilton 1944, Mock 1970.

Hairy-tailed Mole

(*Parascalops breweri*)



RANGE: New Brunswick and se. Quebec w. to se. Ontario s. through e. Ohio and w. North Carolina (Appalachian Mountains).

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Open woods and meadows with light, sandy loam. Prefers areas with vegetative cover and sufficient moisture. Avoids heavy wet soils.

SPECIAL HABITAT REQUIREMENTS: Loose moist well-drained soil.

REPRODUCTION: Age at sexual maturity: 10 months (Eadie 1939). Breeding period: March and April (New Hampshire, Eadie 1939). Gestation period: About 30 days. Young born: April and May. Litter size: 4 or 5, average 4. Litters per year: 1 (possibly 2).

HOME RANGE: About 0.2 acre (0.1 ha) (Eadie 1939).

SAMPLE DENSITIES: An average density of 1.2 moles per acre (3/ha) on 27 acres (11 ha) and a maximum density of 11 individuals per acre (27/ha) has been reported in various habitats in New Hampshire (Eadie 1939). 10 to 12 moles per acre (25 to 30/ha) have been reported in maple-beech-hemlock woods in New York (Hamilton 1939a).

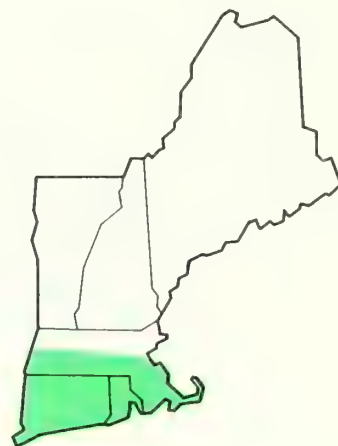
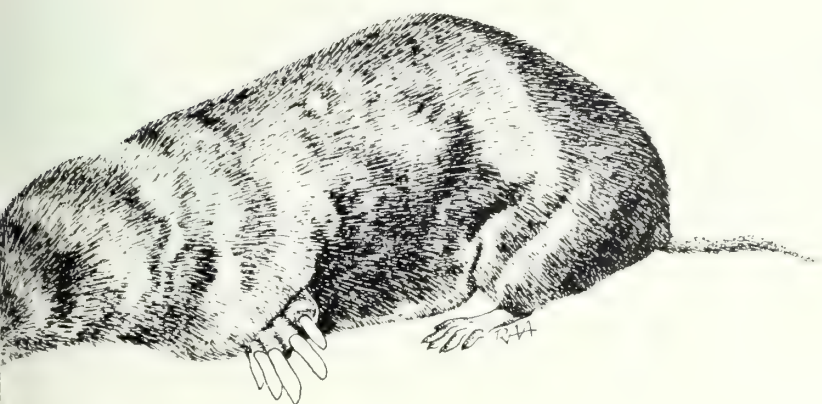
FOOD HABITS: Earthworms, insects (adults, larvae, pupae), millipedes, centipedes, snails, slugs, sowbugs (Godin 1977:37); forages on forest floor at night.

COMMENTS: Constructs two tunnel systems—one shallow (just below surface), the other deep (10 to 18 inches, 25 to 46 cm). Permanent deep tunnels are sites of breeding and winter nests (Eadie 1939) and may be used for several years.

KEY REFERENCES: Eadie 1939, Godin 1977, Hallett 1977

Eastern Mole

(*Amalopos aquaticus*)



RANGE: Massachusetts w. to Wyoming s. to c. Texas and Gulf of Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally com-

HABITAT: Pastures, meadows, lawns, and less often in woodland, in loamy or sandy soils that permit easy digging. Often in moist (not wet) bottomlands where earthworms are plentiful.

ADDITIONAL HABITAT REQUIREMENTS: Soft moist soils containing earthworms.

REPRODUCTION: Age at sexual maturity: 1 year. Breeding period: March and April. Gestation period: 42 to 45 days. Young born: Late April or May. Litter size: 2 to 5. Litters per year: 1.

HOME RANGE: Average area 0.74 ha (0.3 acre) for 7 males in Kentucky, 4 males averaged 1.09 ha (0.4 acre; 3 females averaged 0.28 ha (0.1 acre) (Harvey 1967).

POPULATION DENSITIES: Active throughout the year during all hours of day and night except early morning and early evening (Harvey 1967). Digs tunnels just below surface in dry or cold weather excavates deeper burrows 10 cm or more deep. Spends most of life below ground. Young are independent when about 1 month old (Godin 1977:8). Solitary except during breeding season.

REFERENCES: Arlton 1936, Harvey 1967, Yates and Chrdly 1978.

Star-nosed Mole

(*Condylura cristata*)



RANGE: Southern Labrador w. to sw. Manitoba, se. through n. Ohio, s. in the Appalachians through w. North Carolina and along the coast to the ne. corner North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Prefers low wet ground near bodies of water, swamps, wet meadows, occasionally wet spots in fields or low-lying woods. Has been found in mixed hardwood strands with dry soils near water.

SPECIAL HABITAT REQUIREMENTS: Wet, mucky humus.

REPRODUCTION: Age at sexual maturity: 10 months. Breeding period: April and May. Gestation period: About 45 days. Young born: May and June. Litter size: 3 to 7, average 5.4. Litters per year: 1.

HOME RANGE: Probably about 1 acre (0.4 ha) (Banfield 1974:36).

SAMPLE DENSITIES: 10 individuals per acre (24.7/ha) have been reported in late winter in New York (Eadie and Hamilton 1956).

FOOD HABITS: Aquatic insects, earthworms, crustaceans, slugs, snails, isopods, small fish (occasionally), and small amounts of vegetable material. Forages above ground at night.

COMMENTS: Excellent swimmer, spending much time in water. Usually lives in small colonies (Eadie and Hamilton 1956). Active day and night throughout the year. Has been found swimming under the ice of streams and ponds (Hamilton 1931b). Not uncommon on ground surface.

KEY REFERENCES: Eadie and Hamilton 1956, Hamilton 1931b.

Little Brown Myotis

Myotis lucifugus)



RANGE: Labrador w. to s. Alaska s. to Georgia (in the Appalachians) Arkansas and s. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Breeds in caves in fall. Females seek attics and barns in spring for maternity colonies. Roosting habitat: caves, quarries, mine tunnels, hollow trees, buildings. Winter habitat: caves with constant 40° F (4°C) temperatures and 80 percent relative humidity (Banfield 1974:42)

SPECIAL HABITAT REQUIREMENTS: Females seek dark, cool sites for maternity colonies. Males seek cooler day-time roosts, frequently in valleys near streams and meadows.

REPRODUCTION: Age at sexual maturity: About 6 to 9 months for females, 1 year for males. Breeding period: usually from September to October with fertilization delayed until spring. Gestation period: 50 to 60 days (estimated) (Wimsatt 1945). Young born: Mid-June to early July. Litter size: 1. Litters per year: 1.

WINTER RANGE: Unknown.

POPULATION DENSITIES: Summer density: average 26 bats per square mile (10/km²) over an 8,600-square-mile (22,274 km²) area served by a cave in southern Vermont. Winter density: In caves in southern Vermont—300,000 ± 50,000 (Davis and Hitchcock 1965).

FOOD HABITS: Congregate over water to drink and hawk flying insects, especially midges and mosquitoes, but also beetles, moths, and caddisflies (Anthony and Kunz 1977).

COMMENTS: Breeding colonies of 12 to 1,200 have been reported in Vermont. Females seek nursery sites in late April and disperse July to mid-September (Davis and Hitchcock 1965).

KEY REFERENCES: Barbour and Davis 1969; Cagle and Cockrum 1943; Davis and Hitchcock 1965; Griffin 1940b, 1945; Humphrey and Cope 1976; Wimsatt 1945.

Keen's Myotis

(*Myotis keenii*)



RANGE: Newfoundland and Nova Scotia w. to Saskatchewan, s. to Wyoming and n. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Females seek attics, barns, and tree cavities for small nursery colonies. Both sexes roost singly or in small colonies in crevices under loose tree bark, in cliff walls, or in caves.

SPECIAL HABITAT REQUIREMENTS: For hibernation, Keen's myotis seeks caves or mine shafts with temperatures near 40° F (4.5° C), high relative humidity (Banfield 1974:46), and calm air (Fitch and Shump 1979).

REPRODUCTION: Age at sexual maturity: About 6 to 9 months for females, 1 year for males. Breeding period: September to October with fertilization delayed until spring. Gestation period: 50 to 60 days. Young born: Mid-June to early July. Litter size: 1. Litter per year: 1.

HOME RANGE: Unknown.

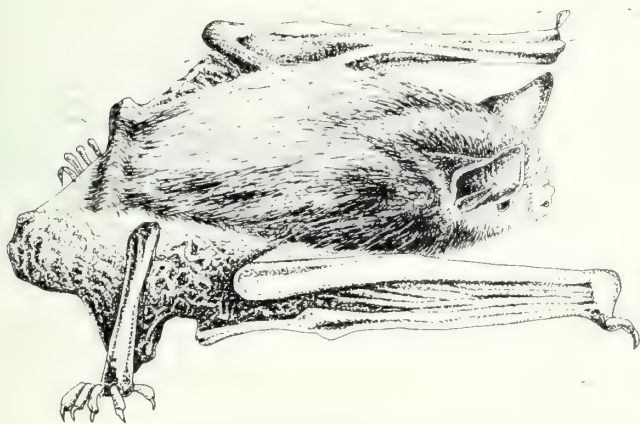
FOOD HABITS: Little is known—probably similar to little brown myotis (Godin 1977:49). Forages over ponds and clearings and high along the forest edge (Cowan and Guiket 1965). Stomachs of three individuals in Indiana contained assassin bugs, moths, butterflies, flies, leaf hoppers, and other unidentified insects (Whitaker 1972a).

COMMENTS: Locally and irregularly distributed with this range. Several hundred individuals were observed hibernating in caves in Canada (Hitchcock 1949). Frequently found mixed with *Myotis lucifugus* during hibernation.

KEY REFERENCES: Banfield 1974, Barbour and Davis 1969, Fitch and Shump 1979, Godin 1977.

Indiana Myotis

(*Myotis sodalis*)



RANGE: Eastern New York and probably s. Vermont and Massachusetts.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and endangered.

FEEDING HABITAT: Favors limestone caves with pools of water. Early females or small maternity colonies bear young in hollow trees or under loose bark. Cannot tolerate high temperatures of attics.

LOCAL HABITAT REQUIREMENTS: Caves for hibernation have cool, stable temperatures of 40° to 46° F (4° to 10° C) throughout the winter (Humphrey 1978). Trees for nursery colonies.

REPRODUCTION: Age at sexual maturity: About 6 months. Breeding periods: Early October (Kentucky). Gestation period: Unknown. Young born: Late June. Litter size: 1.

WING RANGE: Unknown.

FOOD HABITS: Forages in the foliage of crowns of trees 7 to 90 feet (2 to 30 m) tall along the shores of rivers and floodplains (Humphrey et al. 1977). Four colonies examined in Indiana contained ichneumonids, thrips, beetles, and unidentified wasps (Whitaker 1972).

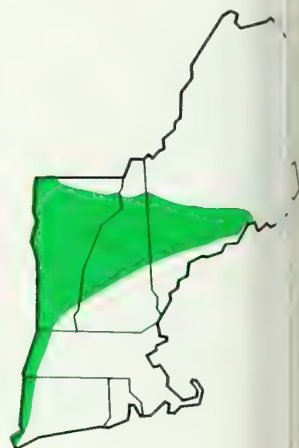
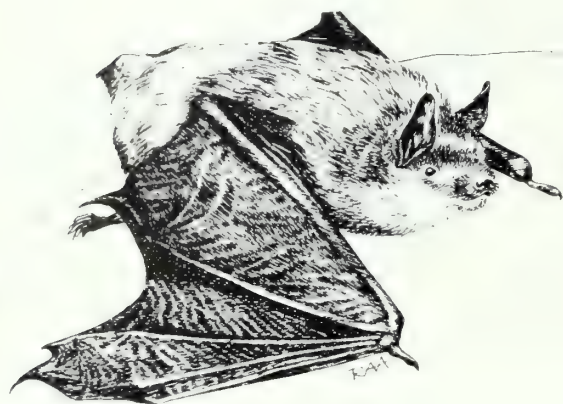
MOVEMENTS: Band recoveries revealed seasonal movement up to 320 miles (512 km) (Hall 1960). Hibernation

period may last from mid-September to early June (averages mid-October to mid-April). 97 percent of total population of Indiana myotis hibernates in four large caves in southern Indiana, Illinois, Missouri, and Kentucky (Hall 1962). Population has decreased by 28 percent in 15 years (Humphrey 1978). It may now be extinct in New England.

KEY REFERENCES: Barbour and Davis 1969; Godin 1977; Hall 1960, 1962.

Small-footed Myotis

(*Myotis leibii*)



RANGE: Southeastern Canada w. through the Midwestern United States to e. Washington s. to Mexico, w. Texas and n. Georgia.

KEY REFERENCES: Banfield 1974, Barbour and Davis 1969, Godin 1977, Hitchcock 1949, Mohr 1936.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: In or near woodland in caves, mine tunnels, buildings, crevices in rocks. Maternity colonies have been observed in buildings (Hitchcock 1955).

SPECIAL HABITAT REQUIREMENTS: Tolerates cold, dry places for hibernation from mid-November to March (Barbour and Davis 1969:104).

REPRODUCTION: Age at sexual maturity: Unknown. Breeding period: Unknown. Gestation period: Unknown. Young born: Single young found at the end of May in California; a pregnant female found in mid-July in Nebraska (Quay 1948). Litter size: Probably 1.

HOME RANGE: Unknown.

FOOD HABITS: Unknown. Probably similar to other myotids. Flies, bugs, beetles, and ants found in stomachs of two specimens (Cockrum 1952:62).

COMMENTS: Hibernates in cold, dry caves or mines from November to April (Pennsylvania). Associated with caves in the foothills of mountains up to 2,000 feet (610 m) in coniferous woodlands (hemlock, spruce, white cedar) (Hitchcock 1949).

Silver-haired Bat

(*Myotis noctivagans*)



RANGE: Southern Canada w. to s. Alaska s. to c. California. Texas and South Carolina.

KEY REFERENCES: Banfield 1974, Barbour and Davis 1969, Godin 1977.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to

HABITAT: Forested areas near lakes or streams. Roosts in edge of trees, in tree cavities and under loose bark as well as in buildings or caves. Frequently found in coniferous forests of mountains.

SPECIAL HABITAT REQUIREMENTS: Dead trees with loose bark or cavities for summer roosting sites, water courses.

REPRODUCTION: Age at sexual maturity: First summer. Breeding period: Late September with delayed fertilization. Gestation period: 50 to 60 days (Druecker 1972). Young born: June or July. Litter size: 2 (occasionally 1). Litters per year: 1.

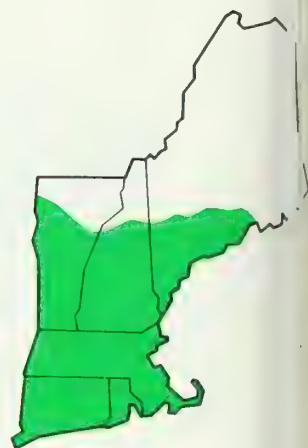
WING RANGE: Unknown.

FOOD HABITS: Feeds among trees and over ponds and streams often less than 20 feet above surface; may prefer catching aquatic insects (Banfield 1974:54).

REMARKS: Solitary in summer. Sexes remain separate, except during breeding period. Migrates to southern parts of range, generally hibernates under loose bark or in tree cavities or buildings. Erratic in abundance throughout its wide range.

Eastern Pipistrelle

(*Pipistrellus subflavus*)



RANGE: Southeastern Canada w. to Minnesota, s. to e. Mexico and Central America. Absent from n. New England, Michigan, and s. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Open woods near water, crevices in cliffs, buildings, caves. Avoids deep woods. Commonly roosts in trees during summer days.

SPECIAL HABITAT REQUIREMENTS: Warm, draft free, damp sites for hibernation (Banfield 1974:57), open woods (Godin 1977:54).

REPRODUCTION: Age at sexual maturity: Probably first summer. Breeding period: October to November and frequently in early spring. Gestation period: About 45 days (Hall 1956:3). Young born: Late June to mid-July. Litter size: Usually 2.

HOME RANGE: Believed to feed within a radius extending at least 5 miles (8 km) from roosting site.

FOOD HABITS: Usually solitary feeder. Prefers to feed over rivers, pastures (if large trees are nearby) and high in bordering trees in search of flies, beetles, ants, bugs, moths, wasps (Banfield 1974:57, Godin 1977:54). Leaf hoppers are important food (Whitaker 1972a).

COMMENTS: Selects warm draftless spots for hibernation (mid-October to May) (Banfield 1974:57) in caves,

mines, and rock crevices (Godin 1977:54). Usually hangs singly or in pairs.

KEY REFERENCES: Banfield 1974, Barbour and Davis 1969, Davis and Mumford 1962, Hall 1956.

Big Brown Bat

(*Myotis fuscus*)



RANGE: Southern Canada w. to Alaska s. to n. Florida
to South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Buildings, bridges, caves, tunnels, hollow
trees in wooded areas; avoids hot attics.

SPECIAL HABITAT REQUIREMENTS: Seems to require cold,
dark areas of caves or buildings for hibernation
(Leachcock 1949).

REPRODUCTION: Age at sexual maturity: Females: first
year. Males: 1 year. Breeding period: September
through March. Peak: September. Fertilization occurs
in April. Gestation period: About 2 months. Young
born: June. Litter size: Usually 2 in the East, 1 in the
West. Litters per year: 1.

HOME RANGE: Probably travels less than 30 miles (48
miles from birthplace (Barbour and Davis 1969:127) and
often uses the same site for summer roosting and hiber-
nation.

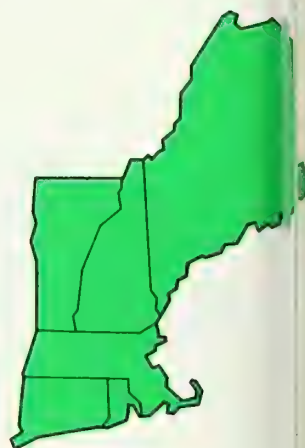
FOOD HABITS: Beetles, wasps, flies, bugs, and other fly-
catching insects (Hamilton 1933a). Beetles accounted for the
largest percentage of diet in Indiana (Whitaker 1972a).
Individuals may use the same feeding ground each night
(Barbour and Davis 1969:121). General in foraging hab-
itat (Humphrey 1982).

COMMENTS: Hibernation begins in November. Nursery
colonies are relatively small, usually with a maximum of
700 individuals (Mills et al. 1975). In New England, nur-
sery colonies seldom exceed 200 individuals.

KEY REFERENCES: Barbour and Davis 1969, Godin 1977,
Mills et al. 1975, Phillips 1966.

Red Bat

(*Lasiurus borealis*)



RANGE: Southern Canada from Nova Scotia w. to British Columbia s. to Texas and n. Florida, also n. California s.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Wooded areas where it roosts in trees 5 to 40 feet (1.5 to 12.2 m) above ground (McClure 1942). Solitary except females with young. Rarely found in buildings or caves except during migration. In Maryland, bats favored deciduous woodlands (Paradiso 1969:54). Greatest numbers were found along fence rows and forest edges, in roosting areas open only from below (Constantine 1966). Most active over water early in evening (Kunz 1973).

SPECIAL HABITAT REQUIREMENTS: Possibly trees for roosting.

REPRODUCTION: Age at sexual maturity: Second summer. Breeding period: August to October, fertilization occurs in spring. Gestation period: 60 to 70 days. Young born: Late May to early July, mid-June in Indiana (Whitaker and Mumford 1972) and Iowa (Kunz 1971). Litter size: 1 to 5, average 2.3. Litters per year: 1.

HOME RANGE: Unknown, however, known to forage 600 to 1,000 yards (546 to 910 m) from day roosts (Jackson 1961:95).

SAMPLE DENSITIES: 1 individual per acre (2.4/ha) in Iowa (McClure 1942).

FOOD HABITS: Feeds at height of tree foliage to ground, sometimes in pairs and often repeatedly follows the same route about 100 yards (91 m) in length (Burt and Gosenheider 1976:37). Eats moths, beetles, bugs, fire crickets, and other insects.

COMMENTS: Migrates south in autumn wintering from Maryland and Washington, D.C., to the Gulf States (Banfield 1974:62, Paradiso 1969:55).

KEY REFERENCES: Barbour and Davis 1969, Godin 1977, Layne 1958, McClure 1942.

Hoary Bat

(*Myotis cinereus*)



RANGE: Southern Canada s. to c. Florida and South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare.

HABITAT: Wooded areas where it roosts 10 to 15 feet (3 to 5 m) above ground in trees (Constantine 1966). Prefers deciduous forests but also uses deciduous woods and wetland edges, hedgerows and trees in city parks (Godin 1977:60).

SPECIAL HABITAT REQUIREMENTS: Forest edge.

REPRODUCTION: Age at sexual maturity: Most become adults during first summer (Druecker 1972). Breeding period: September to November. Peak: Early September. Gestation period: Believed to be about 90 days (Godin 1961). Young born: Mid-May to early July. Litter size: 1 to 4, average 2. Litters per year: 1.

FORAGING RANGE: Feeding range may extend a mile (1.6 km) or more from roosting site (Paradiso 1969:58).

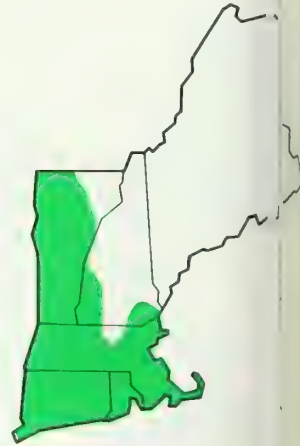
DIETARY HABITS: Forages for insects over lakes and forest edges (Banfield 1974:64). Out of 139 hoary bats examined in New Mexico, 136 contained moths, up to 25 individuals per bat (Ross 1967). Has been seen attacking fireflies in New York (Bishop 1947) and in California (Mason 1950).

COMMENTS: Largest of eastern bats. Females do not form maternity colonies. Sexes separate when young are born and remain segregated most of summer (Godin 1977:61). Migrates in waves to Southern United States and Central America. Individuals have been found in the North during the winter months (Whitaker 1967).

KEY REFERENCES: Barbour and Davis 1969, Bogan 1972, Godin 1977, Seton 1909.

Eastern Cottontail

(*Sylvilagus floridanus*)



RANGE: Eastern United States including extreme s. Canada s. through e. Mexico and parts of Central America. Is spreading into New Hampshire at the expense of the New England cottontail (E. Francq, personal communication).

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Farmlands, pastures, fallow fields, open woodlands, thickets along fence rows and stone walls, edges of forests, swamps and marshes, suburban areas with adequate food and cover. Avoids dense woods.

SPECIAL HABITAT REQUIREMENTS: Brush piles, stone walls, dens or burrows for year-round protection from storms and cold weather. Herbaceous and shrubby cover.

REPRODUCTION: Age at sexual maturity; 2 to 3 months. Most females breed the first spring following birth. Breeding period: March to September. Peak: April to August. Gestation period: 26 to 32 days. Young born: March to September. Young disperse at about 7 weeks. Litter size: 3 to 8, typically 5 or 6. Litters per year: 3 to 4.

HOME RANGE: Sizes range from about a half-acre to 40 acres (0.2 to 16.2 ha) or more (Godin 1977:68). Average 1.4 acres (0.57 ha) for adult males and 1.2 acres (0.48 ha) for adult females in Massachusetts (McDonough 1960). Approximately 8 acres (3.2 ha) (Banfield 1974:77).

SAMPLE DENSITIES: 0.46 animal per acre (1.1/ha) on a 30.4-ha plot in Iowa during month of June, increasing to 1.65 per acre (4/ha) in August, followed by a drop to 0.89 per acre (2.2/ha) in October (Banfield 1974:77).

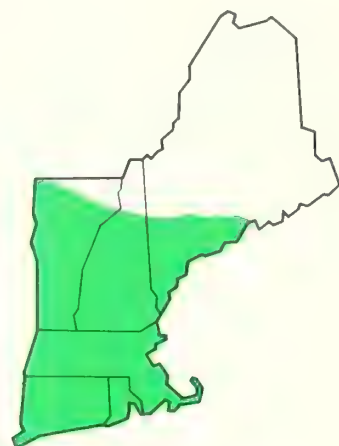
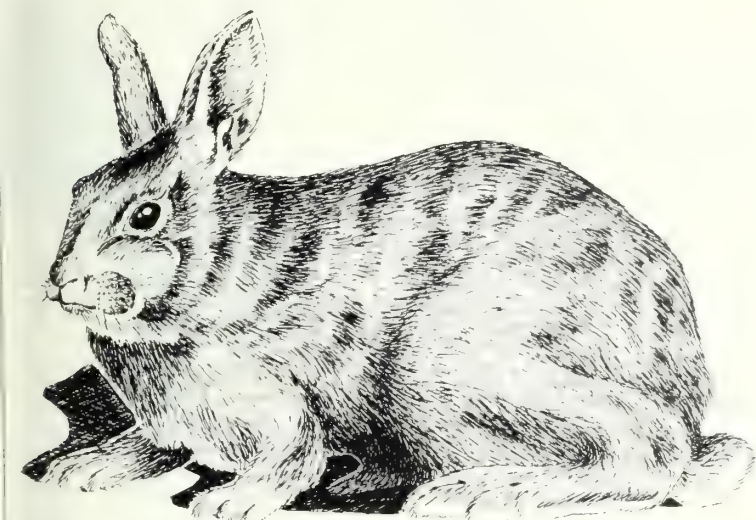
FOOD HABITS: Crepuscular and nocturnal feeder. Feeding takes place 2 to 3 hours after sunrise and within the hour following sunset. Summer foods: tender grasses and herbs. Winter foods: Bark, twigs and buds of shrubs and young trees such as maple, birch, and dogwood.

COMMENTS: The eastern cottontail was introduced to New England in the late 1800's. Female does not dig a burrow—uses abandoned woodchuck hole or digs a shallow nest in soft earth that is well concealed by surrounding vegetation.

KEY REFERENCES: Beule and Studholme 1942, Chapin et al. 1977, Dalke and Sime 1938, Haugen 1942.

New England Cottontail

(*Sylvilagus transitionalis*)



RANGE: Central and s. New England s. through e. New York, Pennsylvania, n. New Jersey and the Appalachian Mountains (to slightly above 4,000 feet, 1,220 m) to Alabama.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon (northern New England) to rare (New Hampshire and Vermont).

HABITAT: Brushy areas, open woodlands, swamps, wetlands (Fay and Chandler 1955). Reported at saltmarshes, and open land (Johnston 1972). Also in young woods associated with clearcuts and in fields or other grasslands. Dense cover and conifers are frequently components of habitats used by this species (Chapman et al. 1982).

ESSENTIAL HABITAT REQUIREMENTS: Young woodlands with dense cover. Seldom ventures far from dense cover (Pringle 1960).

REPRODUCTION: Age at sexual maturity: Probably during second year (Dalke 1942:73). Breeding period: March to September. Peak: March to July (Chapman et al. 1977). Gestation period: 28 days (Dalke 1942: 70). Young born: End of March to early April extending through July (Pringle 1960:14). Litter size: 3 to 8, average 5. Litters per year: 2 or 3.

HOME RANGE: 0.5 to 1.8 acres (0.2 to 0.7 ha) (McDonough 1960). Average 3 acres (1.2 ha) for 17 females and 1.3 acres (3.4 ha) for 10 males in swamp and upland woods (Dalke 1942:42).

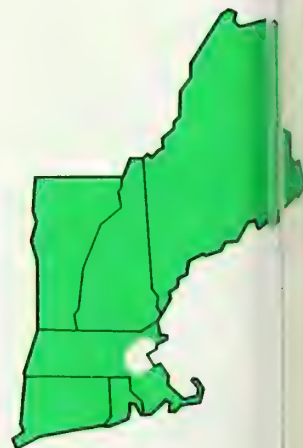
FOOD HABITS: Summer: grasses and herbs. Winter: seedlings, bark, twigs, buds (prefers maple and oak). Coprophagic. Food preference related to availability.

COMMENTS: Crepuscular and nocturnal feeder. No obvious differences were found in the habitat used by the Eastern and New England cottontails (Johnston 1972:38).

KEY REFERENCES: Chapman et al. 1977, Dalke 1942, Fay and Chandler 1955, McDonough 1960, Pringle 1960.

Snowshoe Hare

(*Lepus americanus*)



RANGE: Newfoundland w. to Alaska s. along the n. United States border, and s. in the Sierras, Rockies, and Appalachians.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in suitable habitat.

HABITAT: Deciduous, coniferous, and mixed woodlands (less often deciduous) with dense brushy understory, coniferous swamps, cut-over areas, burns, nearly all types of forests, but favors second growth aspen-birch in vicinity of conifers. In eastern Maine, hare showed a significant shift in activity from coniferous understory in winter to hardwood understory in summer (O'Donoghue 1983).

SPECIAL HABITAT REQUIREMENTS: Dense brushy cover.

REPRODUCTION: Age at sexual maturity: During the spring following birth. Breeding period: March to July. Gestation period: About 37 days. Young born: May to August. Litter size: 1 to 6, average 3. Litters per year: 1 or 2, occasionally 3.

HOME RANGE: Probably about 10 acres (4 ha) (Burt 1957). About 25 acres (10.1 ha) for adult males and 19 acres (7.7 ha) for adult females on an island in northwestern Montana (Adams 1959). Daily ranges for both sexes were about 4 acres (1.6 ha) in mixed woodland—old field habitat in Canada (Bider 1961).

SAMPLE DENSITIES: Populations follow 10- or 11-year cycles with densities ranging from 1 square mile (0.4 km²) to several hundred per square mile (approximately 100 per km²).

FOOD HABITS: Mainly crepuscular and nocturnal. Summer: succulent vegetation such as clover, grasses and ferns. Winter: twigs, buds and bark of small trees and seedlings such as alder and balsam. Coprophagic.

COMMENTS: Pelage turns white in winter following fall molt and returns to brown after spring molt. Young are precocial.

KEY REFERENCES: Aldous 1937, Bider 1961, Dodds 1955, Godin 1977.

European Hare

(*Lepus capensis*)



RANGE: Western Connecticut, e. New York, e. Pennsylvania, and w. New Jersey. Introduced to New York from Europe between 1890 and 1910.

RELATIVE ABUNDANCE IN NEW ENGLAND: Probably uncommon.

HABITAT: Open country (mainly agricultural land) with low vegetation and rolling hills. Occasionally uses open wetlands with little ground vegetation.

SPECIAL HABITAT REQUIREMENTS: Open land.

REPRODUCTION: Age at sexual maturity: Probably first spring following birth. Breeding period: January. Gestation period: About 42 days. Young born: March. Litter size: 1 to 3. Litters per year: Unknown.

HOME RANGE: 11 square miles (28.5 km²) (Eabry 1970). About 12 acres (4.9 ha) (Banfield 1974).

POPULATION DENSITIES: Average population density was about 25 hares per square mile (10/km²) in Ontario with a potential density of 100 hares per square mile (39/km²) under ideal conditions (Banfield 1974).

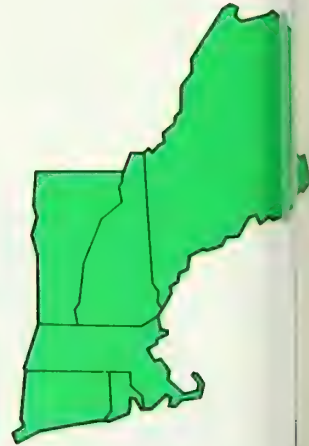
FOOD HABITS: Summer: grass, clover, corn, fruits such as raspberries, apples. Winter: buds, bark and twigs of young trees and seedlings. Coprophagic.

COMMENTS: Builds no nest. Scrapes a hollow in ground near protective vegetation, rocks.

KEY REFERENCES: Banfield 1974, Dean and DeVos 1965, Godin 1977.

Eastern Chipmunk

(*Tamias striatus*)



RANGE: Quebec w. to Manitoba s. through most of e. United States to Louisiana and nw. Florida. Absent from most of Coastal Plain.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Edges or interiors of deciduous woodlands with abundant cover of undergrowth, old logs, stone walls. Semi-open brushlands with ample cover.

SPECIAL HABITAT REQUIREMENTS: Tree or shrub cover, elevated perches.

REPRODUCTION: Age at sexual maturity: Females: 3 months (rarely) to 1 year. Males: 7 months to 1 year. Breeding period: Mid-March to early April and early July to early August. Gestation period: About 31 days. Young born: Mid-April to mid-May and mid-July to mid-August. Litter size: 1 to 8, average 4 or 5. Litters per year: 1 or 2.

TERRITORY: A female defended a 50-yard (45.5 m) radius surrounding the living quarters in oak-hickory woodland in Michigan (Burt 1940). Individuals maintain dominance in a core area that covers about 20 percent of home range (Ickes 1974).

HOME RANGE: Less than 100 yards (91 m) in diameter (Burt 1957). 0.5 to 1.0 acre (0.2 to 0.4 ha) in northern hardwoods in the Adirondacks of New York (Elliott 1878:9)

SAMPLE DENSITIES: 2 individuals per acre (5/ha) at start of breeding season increasing to 4 individuals or more per acre (10+/ha) at end of breeding season (Seton 1957). Up to 30 individuals per acre (74/ha) in good habitats (Seton 1929). Varies geographically and temporally from 0.1 to 15.2 per acre (0.3 to 37.6/ha) (Yerger 1953).

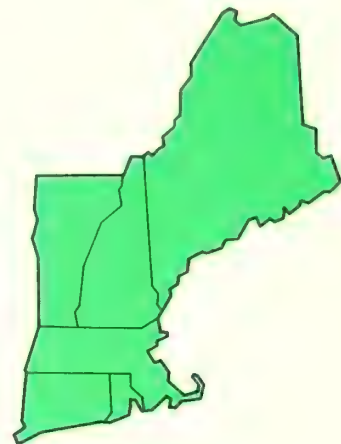
FOOD HABITS: Many kinds of seeds, fruits, nuts, bulbs, insects, meat, and eggs. Feeds during daylight hours.

COMMENTS: Hibernates but may become active for short periods in winter. Largely terrestrial. Den is located in underground tunnel system.

KEY REFERENCES: Allen 1938; Burt 1940, 1957; Elliott 1978; Forbes 1966; Yahner 1978; Yerger 1953, 1955.

Woodchuck

(*armota monax*)



RANGE: Newfoundland w. across the s. Canadian provinces to Alaska s. in the e. United States to Arkansas and Alabama.

KEY REFERENCES: Fall 1971, Grizzell 1955, Snyder and Christian 1960.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Edges of woodlands (seldom in interior), open cultivated land, pastures, meadows, open brushy hill-sides.

SPECIAL HABITAT REQUIREMENTS: Open land.

REPRODUCTION: Age at sexual maturity: 1 year, but commonly breeds during second year. Breeding period: May March to mid-April. Gestation period: 31 to 32 days. Young born: Early April to mid-May. Litter size: 2 to average 4. Litters per year: 1.

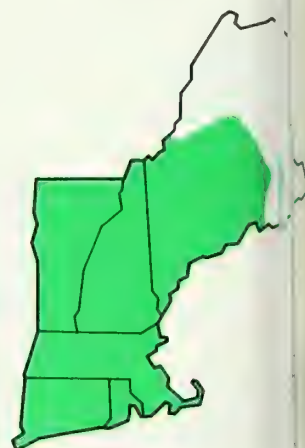
HOME RANGE: 0.25 to 0.50 mile (0.4 to 0.8 km) in diameter (Burt 1957). In alfalfa and clover the home range boundaries are often within 20 yards (18.2 m) of den (Godin 1977:89).

FOOD HABITS: Succulent green vegetation such as alfalfa, clover, grasses, and herbs. Occasionally eats small amounts of insects. Diurnal feeder.

REMARKS: Fossorial except when feeding. Digs extensive system of burrows including a hibernation and nest chamber. Sometimes uses separate summer and winter dens.

Gray Squirrel

(*Sciurus carolinensis*)



RANGE: Southern Quebec to Manitoba s. to Texas and Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to abundant.

HABITAT: Deciduous and mixed forests, especially those with trees that produce mast. River bottomland, woodlots in town, city parks.

SPECIAL HABITAT REQUIREMENTS: Oaks, tall trees for dens or leaf nests (nests are usually 25 feet (7.6 m) or more above ground).

REPRODUCTION: Age at sexual maturity: About 3 months (Smith and Barkalow 1967) to 1 year (Allen 1954). Breeding period: Breeding period: January to February, occasionally May and June (second litter). Gestation period: 44 days. Young born: March to April, August. Litter size: 2 to 5, typically 2 or 3. Litters per year: 1 or 2.

HOME RANGE: 2 to 7 acres (0.8 to 2.8 ha) (Burt and Grossenheider 1976:118). The average minimum home range of 43 individuals in mature oak-hickory woods in West Virginia was 1.24 acres (0.50 ha) (Pack et al. 1967). 1.20 acres (0.49 ha) was the average range of 55 squirrels in mature to over-mature oak-hickory stand in West Virginia (Doebel and McGinnis 1974). 1.40 acres (0.57 ha) in mature oak-hickory, beech and poplar woodlots in Maryland (Flyger 1960).

FOOD HABITS: Diurnal feeder. Consumes nuts, b seeds and grains, fungi, fruits, birds' eggs, inner ba trees. Commonly caches food for future use. Will ea sects and then pupae in spring and summer when pre red foods are scarce (H. Smith, personal commun tion).

COMMENTS: Arboreal, seldom wandering far from tr In autumn squirrels often move home ranges short tances to areas with greater food supplies (Sharp 19 and may occasionally migrate in large numbers c many miles (Larson 1962). Usually several squir share winter dens.

KEY REFERENCES: Godin 1977, Pack et al. 1967, UI 1955.

Red Squirrel

(*Tamiasciurus hudsonicus*)



RANGE: Quebec w. to Alaska s. in the Appalachians to Tennessee and in the Rockies to New Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Coniferous, mixed and occasionally deciduous forests, rural woodlots.

SPECIAL HABITAT REQUIREMENTS: Woodlands with mature trees, conifers preferred.

REPRODUCTION: Age at sexual maturity: 1 year. Breeding period: January to September. Peak: Mid-February to March and June to July. Gestation period: 36 to 40 days. Young born: March to May, August to September. Litter size: 1 to 7, typically 4 or 5. Litters per year: 1 or 2.

HOME RANGE: About 1 acre (0.4 ha) when food is plentiful (Hamilton 1939b). 2.73 to 6.03 acres (1.1 to 2.4 ha) (Bridfield 1974:139). Less than 200 yards (182 m) in diameter (Burt and Grossenheider 1976:121). Defends feeding and den sites.

FOOD HABITS: Diurnal and crepuscular. Feeds on seeds of conifers, nuts, buds, sap, tender leaves, fruits, flowers, fungi, insects, birds' eggs, and the young of small vertebrates. Caches food for winter use.

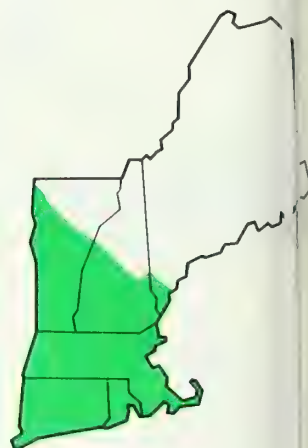
COMMENTS: Prefers to nest in natural cavity or abandoned woodpecker hole. When unavailable, squirrels may construct globular leaf nests near top of tree or next

to trunk or use ground burrows. Become inactive for short periods in winter to avoid cold and storms.

KEY REFERENCES: Hamilton 1939b, Hatt 1929, Klugh 1927, Layne 1954.

Southern Flying Squirrel

(*Glaucomys volans*)



RANGE: Eastern North America from Nova Scotia w. to the Great Lakes and s. to East Texas and s. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Mature deciduous and mixed forests especially beech-maple, oak-hickory and aspen.

SPECIAL HABITAT REQUIREMENTS: Several nest sites per individual (Muul 1968), mature woodland with cavity trees. Favors cavities with entrance diameters of 1.6 to 2 inches (40 to 50 mm) (Dolan and Carter 1977).

REPRODUCTION: Age at sexual maturity: About 6 months. Breeding period: Late February to early March; June to July. Gestation period: About 40 days. Young born: April and May; July and August. Peaks: April and August (Massachusetts). Litter size: 2 to 6, average 3 to 4. Litters per year: 2.

HOME RANGE: Average 0.41 acre (0.17 ha) for females (may defend entire home range) and 0.53 acre (0.21 ha) for males (no defense) in oak-maple habitat in New York (Madden 1974).

SAMPLE DENSITIES: Densities of up to 5 individuals per acre (12/ha) have been reported in woodland in New York (Sollberger 1943).

FOOD HABITS: Hickory and other nuts, acorns, seeds and fleshy fruits. Also takes insects and occasionally

birds' eggs and fledglings. Most carnivorous of the squirrels. Stores food in den for winter use.

COMMENTS: Nocturnal feeders; highly sociable—several squirrels may occupy same den at once, especially in winter. Favors abandoned woodpecker holes for den sites. Active throughout the year except during extreme winter cold.

KEY REFERENCES: Burt 1940; Jordan 1948; Muul 1968; Sollinger 1940, 1943.

Northern Flying Squirrel

Glaucomys sabrinus)



RANGE: Canada w. to Alaska, s. in the Eastern United States to s. New England, and in the Appalachians to North Carolina. To the w. the range extends s. to North Dakota, Utah (Rocky Mountains), and n. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Forests of mixed mature conifers and deciduous trees; less often in purely hardwood forests. Favors cool, heavily wooded areas above 1,000 feet (305 m) in elevation.

SPECIAL HABITAT REQUIREMENTS: Mature trees, cavities for winter dens. Arboreal lichens for winter food.

REPRODUCTION: Age at sexual maturity: Probably 6 months to 1 year. Breeding period: February to May and July. Gestation period: About 37 days. Young born: Late March to early July; late August or early September (Godin 1977:103). Litter size: 2 to 6, typically 4 or 5. Litters per year: 1 or 2.

HOME RANGE: Unknown.

FOOD HABITS: Nocturnal feeder. Eats a variety of nuts, especially acorns; also takes seeds, catkins, fruits, buds, insects, mushrooms, birds' eggs, and nestlings. Caches food in tree cavities.

COMMENTS: Summer nest may be constructed on a limb or net to tree trunk (usually a conifer). Winter nest is in a

cavity, often an old woodpecker hole. Active throughout year except during extreme winter cold. Often highly social in winter dens.

KEY REFERENCES: Banfield 1974, Cowan 1936, Godin 1977.

Beaver

(*Castor canadensis*)



RANGE: Most of North America with the exception of the high arctic, parts of the sw. United States, Florida, and Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Small to large slowly flowing brooks, streams, or rivers that are usually, but not necessarily, bordered by woodland.

SPECIAL HABITAT REQUIREMENTS: Wetlands that provide an adequate food supply and sufficient water depths.

REPRODUCTION: Age at sexual maturity: 1-1/2 to 2 years (Lason 1967). Breeding period: Mid-January to mid-March. Peak: Mid-February. Gestation period: About 106 days. Young born: Mid-May to early June. Litter size: 1 to 9, typically 3 to 5. Litter size may be related to type and amount of available food (Huey 1956). Litters per year: 1.

HOME RANGE: Beavers have been known to range in excess of 450 feet (137 m) from water in search of food (Hiner 1938) but generally remain much closer to lodge.

FOOD HABITS: Mainly a nocturnal feeder. Consumes bark of deciduous trees especially aspen, balsam poplar, alder, willow, birch, and maple. Also takes herbaceous vegetation especially aquatics, and some grasses. Caches food under ice for winter use.

COMMENTS: Monogamous pair bond is life-long. Constructs dams to retain water and large lodge of mud and sticks to enclose den for raising of young and winter shelter or digs burrows in banks.

KEY REFERENCES: Godin 1977, Hodgdon and Larsen 1973, Jenkins and Busher 1979.

Peromyscus maniculatus

(*Peromyscus maniculatus*)



RANGE: Most of North America except n. Canada, w. Mexico, the se. United States and the Atlantic Coastal plain.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Mainly occurs in interiors or along edges of coniferous or mixed forests, along field borders, stone walls, in out-buildings near areas with small trees and other ground cover (Godin 1977:111). Uses recent forest clearcuts (Kirkland 1977b).

REPRODUCTION: Age at sexual maturity: Females: 40 to 60 days. Males: about 60 days. Breeding period: March through October. Gestation period: About 23 days. Young born: April to October. Litter size: 3 to 7, average 4. Litters per year: 3 or 4.

HOME RANGE: Average 2.3 acres (0.9 ha) for adult males and 1.4 acres (0.6 ha) for adult females in virgin hardwood forest in Michigan (Blair 1942). 0.10 to 0.31 acre (0.04 to 0.13 ha) for adult males and 0.12 to 0.25 acre (0.05 to 0.10 ha) for adult females (Manville 1949).

POPULATION DENSITIES: Density normally ranges from a low of 1 mouse per 2 acres (1/0.8 ha) in spring to a high of 22 mice per 2 acres (22/0.8 ha) in autumn (Banfield 1971:165).

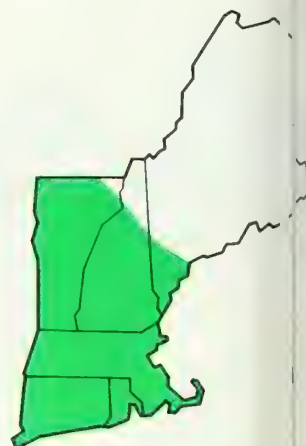
FOOD HABITS: Nuts, seeds, grains, fruits, mushrooms. Also eats small invertebrates such as worms, snails, insects, and occasionally carrion. Caches food in fall for winter use.

COMMENTS: Nocturnal. Active throughout the year except during severe cold spells or winter storms. Nests in a variety of places including stone walls, buildings, old burrows of small mammals, under logs or in tree cavities.

KEY REFERENCES: Blair 1942, Choate 1873, Godin 1977, King 1968, Klein 1960.

White-footed Mouse

(*Peromyscus leucopus*)



RANGE: Throughout most of the Eastern United States except n. Maine, n. Minnesota, n. Wisconsin, Florida and coastal sections of the se. United States. Does not occur w. of Arizona and Montana.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Interiors and edges of deciduous, mixed, and coniferous forests from sea level to above treeline. Clearcuts, brushy woodland clearing, pastures, streamside thickets, buildings.

REPRODUCTION: Age at sexual maturity: 6 to 7 weeks. Breeding period: Late February to November. Gestation period: 22 to 25 days. Young born: March to December. Litter size: 1 to 7, typically 3 to 4.

HOME RANGE: Sizes ranged from 0.16 to 0.54 acre (0.06 to 0.22 ha) for adult males and 0.06 to 0.36 acre (0.02 to 0.15 ha) for adult females in mature oak-hickory in southern Michigan (Burt 1940).

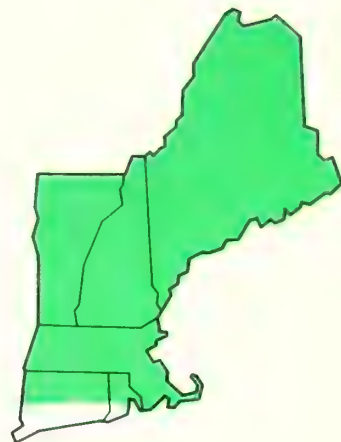
FOOD HABITS: Seeds, acorns, nuts, fruits, tender green plants, insects, and small amounts of meat (carrion). Commonly stores food for future use.

COMMENTS: Nests in a variety of places including stone walls, tree cavities, under stumps or logs or in buildings. Nocturnal and active in all seasons.

KEY REFERENCES: Burt 1940, King 1968, Snyder 1956, Svihla 1932.

Southern Red-backed Vole

(*Reithronomys gapperi*)



RANGE: Canadian Provinces s. in the United States in the Carolinians to n. Georgia and in the Rockies to sw. New Mexico. Also occurs in the n. border states.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Cool moist deciduous, mixed, or coniferous forests among mossy rocks, logs, tree roots, or other cover. Less commonly found near stone walls at woodland edges or near talus slopes. Favors damp situations in coniferous or mixed woods. Highest densities found in climax communities (Cameron 1958:46). Uses young tree cuts in deciduous or coniferous woodlands (Hilland 1978) and mixed forest (Lovejoy 1975).

SPECIAL HABITAT REQUIREMENTS: Water sources such as streams, brooks or bogs, debris cover (fallen trees, stumps, rocks, slash).

REPRODUCTION: Age at sexual maturity: Possibly 3 or 4 months (Blair 1941:683). Breeding period: Mid-January to late November. Peak: February to October. Gestation period: 17 to 19 days. Young born: February to December. Litter size: 1 to 8, typically 4 to 6. Litters per year: probably 2 or more.

HOME RANGE: About 0.25 acre (0.10 ha) (Burt and Grossenheider 1976:182); about 0.57 acre (0.23 ha) for 1 female and 3.56 acres (1.44 ha) for 1 male in virgin hardwood forest in northern Michigan (Blair 1941).

FOOD HABITS: Mainly green vegetation but also eats seeds, nuts, fungi, bark, insects, and carrion.

COMMENTS: Mainly nocturnal, active year long. Commonly uses burrow systems of moles or other mammals. Nests under logs, stumps, roots, or snow (winter).

KEY REFERENCES: Criddle 1932; Miller and Getz 1972, 1973; Svihla 1930.

Meadow Vole

(*Microtus pennsylvanicus*)



RANGE: Southern two-thirds of Canada and s. Alaska, s. to Washington, n. New Mexico, Missouri and n. Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Fields, pastures, orchards, freshwater and salt water marshes and meadows, borders of streams and lakes, open and wooded swamps, bogs; less commonly in open woods and clearcuts.

SPECIAL HABITAT REQUIREMENTS: Herbaceous vegetation, loose organic soils.

REPRODUCTION: Age at sexual maturity: Females: about 25 days. Males: about 45 days. Breeding period: Throughout the year, if snow provides insulating cover. Peak: April to October. Gestation period: About 21 days. Young born: Throughout the year. Litter size: 1 to 9, typically 4 or 5. Litters per year: May produce 5 to 10. Known to produce 17 (Hamilton 1941).

HOME RANGE: Seldom exceeded 0.06 acre (0.02 ha) in New York in good habitat (Hamilton 1937). Sizes may vary range from 0.08 to 0.23 acre (0.03 to 0.09 ha) (Banfield 1974). Defensive behavior displayed during male encounters may indicate that they defend territories (Getz 1961b).

FOOD HABITS: Eats mainly vegetable material especially tender grasses, bulbs, cambium of roots and stems, seeds, and grains. Occasionally caches food when supply is abundant and takes small amounts of meat when available.

COMMENTS: Active day and night throughout the year. Builds extensive tunnel and runway systems. Nests under boards, rocks, logs, and in other sheltered spots including tunnels. May damage nursery and orchard stock. There is a cyclic fluctuation in populations of about 4 years (Hamilton 1937). The beach vole, found only on Muskeget Island, Massachusetts, is here considered the meadow vole. Burt and Grossenheider (1976:183) indicated that it may be a separate species, *M. breweri*; Collins (1977:124) gives the beach vole species status.

KEY REFERENCES: Bailey 1924, Blair 1940b, Getz 1961b, Hamilton 1937.

Rock Vole

(*Microtus chrotorrhinus*)



RANGE: Cape Breton Island and e. Quebec w. to ne. Minnesota. The mountains of n. New England, s. in the Appalachians to North Carolina.

RELATIVE ABUNDANCE IN NEW ENGLAND: Unknown, possibly rare, but may be locally common in appropriate habitats.

HABITAT: Coniferous and mixed forests at higher elevations. Favors cool, damp, moss-covered rocks and talus slopes in vicinity of streams. Kirkland (1977a) captured rock voles in clearcuts in West Virginia, habitat not previously reported for this species. Timm and others (1977) found voles using edge between boulder field and mature forest in Minnesota. They have been taken at a new elevation (1,509 feet, 460 m) in the Adirondacks (Kirkland and Knipe 1979).

SPECIAL HABITAT REQUIREMENTS: Cool, moist, rocky woodlands with herbaceous groundcover and flowing water.

REPRODUCTION: Age at sexual maturity: Females and males are mature when body length exceeds 140 mm and 150 mm, respectively, and total body weight exceeds 30 g for both sexes (Martin 1971). Females born in late spring produce litters in first summer (Timm et al. 1977). Breeding period: Late March to mid-October (Martin 1971). Gestation period: Unknown. Young born: Early spring to fall; peak: June. Litter size: 1 to 7, typically 3 or 4. Litters per year: Up to 3.

HOME RANGE: Unknown.

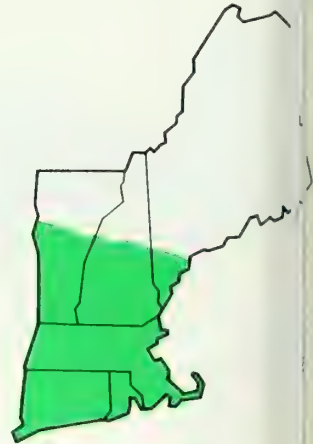
FOOD HABITS: Bunchberry, wavy-leafed thread moss, blackberry seeds (Martin 1971). May browse on blueberry bushes (twigs and leaves), mushrooms, and Clinton's lily. A captive subadult ate insects (Timm et al. 1977). Seems to be diurnal with greatest feeding activity taking place in morning (Martin 1971). Less active in afternoon in northern Minnesota (Timm et al. 1977).

COMMENTS: Occurs locally in small colonies throughout its range. Natural history information is lacking for this species. Habitat preferences seem to vary geographically.

KEY REFERENCES: Banfield 1974, Burt 1957, Kirkland 1977a, Martin 1971, Timm et al. 1977.

Woodland Vole

(*Microtus pinetorum*)



RANGE: Northcentral New England, w. to c. Wisconsin s. to e. Texas and n. Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Deciduous forests, grasslands, meadows, and orchards. Occurs in marshes and swamps but favors well-drained uplands.

SPECIAL HABITAT REQUIREMENTS: May require ground-cover of leaves (duff) or grass; moist well-drained soils.

REPRODUCTION: Age at sexual maturity: 2 months (Hamilton 1938). Breeding period: Mid-February to mid-November. Gestation period: About 24 days. Young born: Early March to early December. Litter size: 2 to 4.

HOME RANGE: About 0.25 acre (0.10 ha) in oak-hickory woods in Michigan (Burt 1940). Home ranges of voles in Connecticut had average maximum diameters of 30.7 yards (33.7 m) for females and 30 yards (32.7 m) for males (Miller and Getz 1969).

SAMPLE DENSITIES: Densities ranged from 0 to 6 individuals per acre (0 to 14.6/ha) in upland oak woods (Miller and Getz 1969).

FOOD HABITS: Subterranean tubers, roots and bulbs; seeds, nuts, fruits, bark, and leaves. Often caches large amounts of food in burrows.

COMMENTS: Highly fossorial spending much time digging tunnel systems and foraging below ground. Tunnels may be dug as deep as 12 inches (30.5 cm) but are generally 3 or 4 inches (7 to 10 cm) below ground surface. Nests are built under logs or rocks or in burrows well below ground. Active throughout the year. May be a severe pest species in nurseries and orchards in the Northeast. Also called the pine vole.

KEY REFERENCES: Benton 1955, Burt 1940, Hamilton 1938, Miller and Getz 1969.



RANGE: Throughout most of Canada except portions directly e. and nw. of Hudson Bay. In most of the United States except parts of California, Texas, South Carolina, Georgia, and all of Florida.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Marshes, shallow portions of lakes, ponds, swamps, sluggish streams, drainage ditches. Most abundant in areas with cattails.

SPECIAL HABITAT REQUIREMENTS: Wetlands with dense emergent vegetation and stable water levels.

REPRODUCTION: Age at sexual maturity: Possibly 6 months, and perhaps as early as 4 months (H. Smith, personal communication). Breeding period: Late February to August (H. Smith, personal communication). Mid-July to September (Chamberlain 1951) in Massachusetts. Gestation period: 28 or 30 days (Godin 1977:133). Young born: April or May and June or July; September and early October litters have been observed (H. Smith, personal communication). Litter size: 1 to 8, typically 5 or 6. Litters per year: Average 3 (H. Smith, personal communication). Litter size positively correlates with latitude while number of litters per year is inversely related (Boe 1977 cited in Perry 1982).

HOME RANGE: Usually within 200 yards (182 m) or den (Errington and Errington 1937). Territorial. Females with young will defend nest site. Most foraging within 150 yards (50 ft.) of the primary lodge and few movements exceeded 150 meters (500 ft.) (MacArthur 1978).

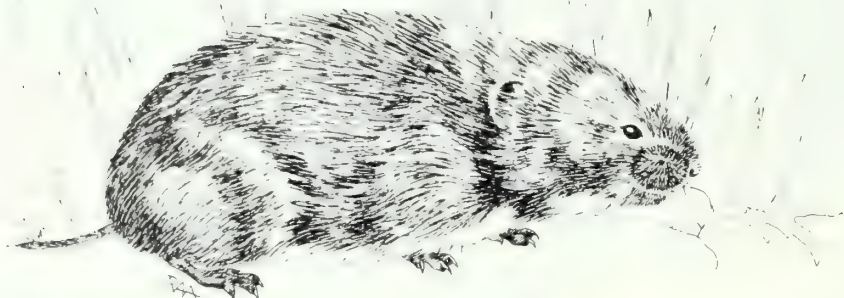
FOOD HABITS: A variety of aquatic plants especially cattails, reeds, pondweeds, bulrushes, and water lilies, fresh water clams, and other small aquatic animals. Builds roofed feeding platforms near house.

COMMENTS: May construct a dome-shaped chamber of weeds over water (less than 2 feet (0.6 m) deep) for nest or may dig a den in stream or ditch bank. Mainly nocturnal but often seen in daylight. Active throughout the year. Populations tend to follow a 10-year cycle (Elton and Nicholson 1942).

KEY REFERENCES: Errington 1961, 1963; Godin 1977; Johnson 1925; Shanks and Arthur 1952.

Southern Bog Lemming

(*Synaptomys cooperi*)



RANGE: Quebec w. to Manitoba, s. to Kansas, Arkansas, Virginia, and Maryland.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon, in very scattered colonies.

HABITAT: Uses a variety of habitat including marshes, open meadows and orchards, moist deciduous and mixed forests. Favors sphagnum bogs and deciduous woodlands with a thick layer of loose duff. Uses clearcuts and other small forest openings with adequate ground-cover (Kirkland 1977b, McKeever 1952).

SPECIAL HABITAT REQUIREMENTS: Moist soils.

REPRODUCTION: Age at sexual maturity: Unknown. Breeding period: Throughout the year. Peak: April to September. Gestation period: 21 to 23 days. Young born: Throughout the year; most young are born between May and September. In New Jersey, females produced a litter every 67 days (average) in spring and summer (Conner 1959). Litter size: 1 to 8, typically 2 to 5.

HOME RANGE: 1 acre (0.40 ha) for 1 individual in sphagnum bog with tamarack and black spruce forming a dense canopy (Buckner 1957). 0.20 to 0.50 acre (0.08 to 0.20 ha) (Banfield 1974:188). Females defend nest.

FOOD HABITS: Tender parts of herbaceous plants, especially leaves, stems and seeds of grasses and sedges, fruits. Occasionally takes fungi, bark, and insects.

COMMENTS: Tunnel systems are deep, 6 to 12 inches (15 to 30 cm) below ground and complex with many chambers for resting, feeding, and storing of food. Surface runways serve as travel lanes. Winter nest may be located in burrow, summer nest may be on surface in clump of grass. Active during the day and night at all seasons of the year. Life history is poorly known.

KEY REFERENCES: Buckner 1957, Conner 1959, Goss 1977.

Northern Bog Lemming

(*Reithrodontomys borealis*)



RANGE: Labrador w. to c. Alaska, s. to Washington, se. Manitoba and n. New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Rare and local.

HABITAT: Sphagnum bogs, damp weedy meadows, mossy spruce woods, hemlock and beech forests.

SPECIAL HABITAT REQUIREMENTS: Moist to wet loose soils free of mold.

REPRODUCTION: Age at sexual maturity: Unknown. Breeding period: Unknown. Gestation period: Unknown. Young born: May to August. Litter size: 4 to 8, usually 4.

DIET: Unknown.

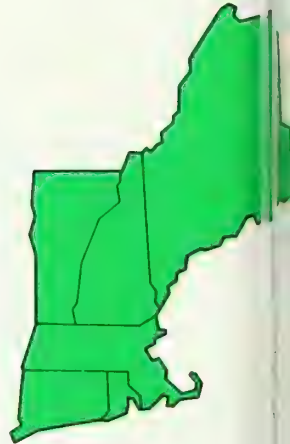
FOOD HABITS: Succulent parts of grasses and sedges, mosses, fungi.

REMARKS: Uses burrows several inches below ground and shallow runways on surface. This species' life history is poorly known. Two reported New England specimens are from Mt. Katahdin, Maine, and Fabyans at the base of Mt. Washington, New Hampshire (Godin 1977: 136). Finch (personal communication) reported a third record from Mt. Moosilauke, New Hampshire.

KEY REFERENCES: Banfield 1974, Godin 1977.

Norway Rat

(*Rattus norvegicus*)



RANGE: Throughout most of North America with numbers varying with climate and habitat.

KEY REFERENCES: Calhoun 1962, Davis 1953.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Concentrates in areas where food is abundant such as waterfronts, farms, cities, and dumps. They may also inhabit rural and suburban residences.

SPECIAL HABITAT REQUIREMENTS: Buildings, dumps, or loose soil for digging burrows near food supply.

REPRODUCTION: Age at sexual maturity: 80 to 85 days. Breeding period: Throughout the year. Peaks: Spring and autumn. Gestation period: 21 to 22 days. Young born: In all seasons of year. Litter size: 2 to 14, average 9. Litters per year: 3 to 12, average 6.

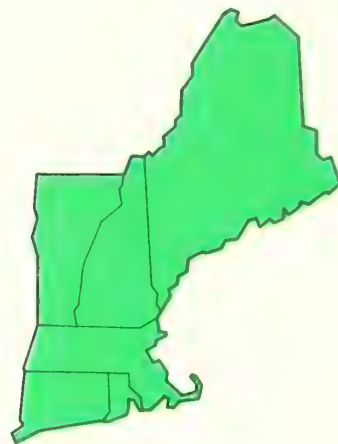
HOME RANGE: About 25 to 50 yards (23 to 46 m) in diameter (Banfield 1974: 222). Movements were confined to an area 100 to 150 feet (30 to 46 m) in diameter both in residential and farm areas (Davis 1953).

FOOD HABITS: Omnivorous, taking fruits, vegetables, grains, carrion and fresh meats, garbage.

COMMENTS: Colonial and closely associated with man. Probably the most economically important of the rodents because of the damage they cause to buildings and the diseases they spread to humans. Active mainly at night throughout the year. May dig extensive burrow systems for nesting and escaping predators.

House Mouse

(*Mus musculus*)



RANGE: Throughout North American from s. Canada to Mexico.

RELATIVE ABUNDANCE IN NEW ENGLAND: Abundant.

HABITAT: Buildings, fields, corncribs, and so on. Often grows in fields and uses existing mouse runways during warm seasons of year and moves indoors to escape winter cold.

SOCIAL HABITAT REQUIREMENTS: Buildings in winter.

REPRODUCTION: Age at sexual maturity: 8 weeks (females) (Godin 1977:142), 5 weeks (Banfield 1974:224). Breeding period: Throughout the year. Peak: Early spring to late summer. Gestation period: 19 to 21 days. Young born: Throughout the year. Litter size: 3 to 12, typically 4 or 5. Litters per year: 5 to 8, typically 6.

HOME RANGE: Average 1,560 square feet (145 m²) for males and females (Lidicker 1966) in brush-grass habitat (ocean island) with high population of *Microtus*. 3,925 square feet (365 m²) in area with low (1 individual) *Microtus* population (Quadagno 1968).

SAMPLE DENSITIES: Densities of 300 or more mice per acre (74 + /ha) were reported on an island (Lidicker 1966).

FEED HABITS: Fruits, grains, seeds, vegetables, plant roots, insects, almost any sweet or high protein food. Occasionally caches food.

COMMENTS: Mainly nocturnal, active throughout the year. Colonial and highly social—may construct communal nests.

KEY REFERENCES: Godin 1977, Lidicker 1966, Quadagno 1968.

Meadow Jumping Mouse

(*Zapus hudsonius*)



RANGE: Most of Canada, Alaska and the continental United States, s. to n. Georgia and w. to Colorado.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common.

HABITAT: Moist, open grassy and brushy marshes and meadows, willow-alder thickets occurring along water courses, swamps and transition areas between lowlands and wooded uplands and mixed), occasionally dry meadows. Seems to prefer areas with numerous shrubs and small trees.

SPECIAL HABITAT REQUIREMENTS: Herbaceous ground-cover, loose soils for burrowing.

REPRODUCTION: Age at sexual maturity: Less than 1 year. Young females of first litter may breed during first year (Quimby 1951). Breeding period: Late April to early September. Peaks: Early June, July, and August (Hamilton and Whitaker 1979:248). Gestation period: 18 days. Young born: May to early October. Litter size: 2 to 8, average 5 to 6. Litters per year: 2 possibly 3.

HOME RANGE: Average 0.38 acre (0.15 ha) for females and average 0.43 acre (0.17 ha) for males in Itasca Park in Minnesota (Quimby 1951). Approximately 0.89 acre (0.36 ha) (average) for males and 0.92 acre (0.37 ha) (average) for females in grassy area in Michigan (Blair 1940c).

FOOD HABITS: Invertebrates, especially beetles and cutworms are taken in spring followed by seeds, fruits,

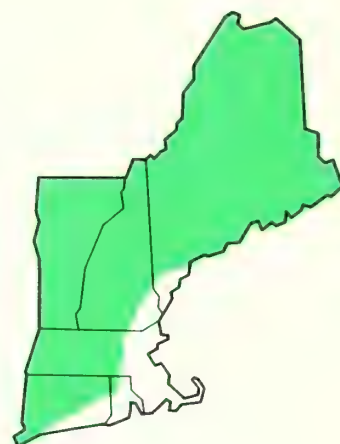
nuts, and subterranean fungi as summer progresses. Feeds on rootlets exposed by stream erosion (Campana 1958:49).

COMMENTS: Mainly nocturnal and solitary. Hibernates for longer periods in winter than most mammals (Goss 1977:144) in chambers 1 to 3 feet below ground, usually in a bank or hill (Banfield 1974:227).

KEY REFERENCES: Blair 1940c; Quimby 1951; Sheldon 1934; Whitaker 1963a, 1972b.

Woodland Jumping Mouse

(*Reithrodon insigne*)



RANGE: Canadian maritime provinces s. to n. New Jersey
w. Maryland w. to ne. Ohio.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally com-

HABITAT: Areas with herbaceous groundcover and low
plants in both deciduous and coniferous forests,
frequently in brush and herbaceous vegetation border-
streams, lakes, or ponds. Uses recent clearcuts with
herbaceous cover (Kirkland 1977b). Seldom ventures
to bare open areas.

ESSENTIAL HABITAT REQUIREMENTS: Moist cool woodland,
loose soils for burrowing, herbaceous cover (Whitaker
and Wrigley 1972).

REPRODUCTION: Age at sexual maturity: Possibly as early
as 30 days (Layne and Hamilton 1954). Breeding period:
May to August. Gestation period: 21 to 25 days. Young
born: Late May to late August. Occasionally a second
litter born in September (Godin 1977:148). Litter size: 1
to 8, typically 5. Litters per year: 1 or 2.

HOME RANGE: Average 8.96 acres (3.63 ha) for an adult
male and 6.55 acres (2.65 ha) for an adult female (Ban-
croft 1974:230). 1.0 to 6.5 acres (0.40 to 2.63 ha) for fe-
male and 1.0 to 9.0 acres (0.40 to 3.64 ha) for males in
large hardwood forest in Michigan (Blair 1941).

DIETARY HABITS: Tender parts of herbaceous plants, roots,
insect underground fungi, seeds, insect larvae and
insects. Does not cache food.

COMMENTS: Nocturnal feeder, hibernates from October
or November until April or May. Nest may be built in
excavated chamber within burrow system usually about
4 inches (10 cm) below the surface of ground or under
log or stump.

KEY REFERENCES: Blair 1941; Brower and Cade 1966;
Hamilton 1935; Lovejoy 1973; Preble 1956; Sheldon
1934, 1938; Whitaker 1963b, Wrigley 1972.

Porcupine

(*Erethizon dorsatum*)



RANGE: Nova Scotia and Quebec w. across boreal Canada to Alaska, s. in the Appalachian to n. Virginia; in the Midwest to n. Minnesota and Wisconsin, and in the West to nw. Texas, Arizona, and e. California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Mixed or coniferous forests especially northern hardwood-hemlock, with adequate denning sites. Not restricted to any plant or edaphic community (Dodge 1982).

SPECIAL HABITAT REQUIREMENTS: Den sites in rock ledges, trees or other protected places.

REPRODUCTION: Age at sexual maturity: 15 to 16 months. Breeding period: October through December, occasionally later. Gestation period: 205 to 217 days, average 210 days (Shadle 1951). Young born: April to June. Litter size: 1, rarely more. Litters per year: 1.

HOMERANGE: Winter ranges averaged 6 acres (2.4 ha) in New Hampshire (Faulkner and Dodge 1962) and 13.3 acres (5.4 ha) in the Adirondacks of New York (Shapiro 1949). Spring and summer ranges ranged from 32 to 36 acres (13.0 to 14.6 ha) in conifer-hardwood forest in Minnesota (Marshall et al. 1962). Varies with climate and habitat (Dodge 1982).

FOOD HABITS: Herbaceous and woody vegetation. Eats large quantities of grasses, leaves, twigs, buds, and bark. Hemlock is a major winter food in the West (Dodge 1967).

COMMENTS: Mainly nocturnal, remaining active throughout the year. Den may be in rocky cave, ledge, in hollow log, abandoned building, or abandoned fox or beaver den; winter denning may be in groups (Dodge 1982). Generally is solitary throughout the year, may spend the winter in a "station tree," usually a hemlock or white spruce. May damage commercial grown trees or buildings.

KEY REFERENCES: Costello 1966, Curtis and Kock 1944, Dodge 1967, Shapiro 1949.



RANGE: New England (except Rhode Island), New York, Pennsylvania, n. Ohio, s. to Texas and w. to California.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to common.

HABITAT: Edges of second growth forests, open brushy land, fallow agricultural land, forest openings created by fire or logging.

PREFERRED HABITAT: Coyotes may concentrate in low-lying areas with abundant snowshoe hares and deer (Ozoga and Harger 1966).

ENVIRONMENTAL HABITAT REQUIREMENTS: Open or semiopen areas for hunting, secluded den sites.

REPRODUCTION: Age at sexual maturity: 1 to 2 years. Breeding period: February (in northern part of range). Gestation period: 60 to 65 days. Young born: April or May. Litter size: 4 to 8, occasionally more, typically 5 to 6.

HOME RANGE: Size may exceed an area 5 miles (8 km) in diameter depending on food supply and time of year (Ozoga, 1977). Range sizes of radio-tracked individuals are greater for males (average 26.3 mi², 68 km²) than for females (6.3 mi², 16 km²) in Minnesota (Berg and Chesson 1978). Pack animals defend well-defined territories, but solitary individuals do not (Bekoff and Wells 1983).

SAMPLE DENSITIES: The winter density of coyotes on an island in Lake Michigan was estimated at 1 animal per 2 square miles (5.2 km²) (Ozoga and Harger 1966).

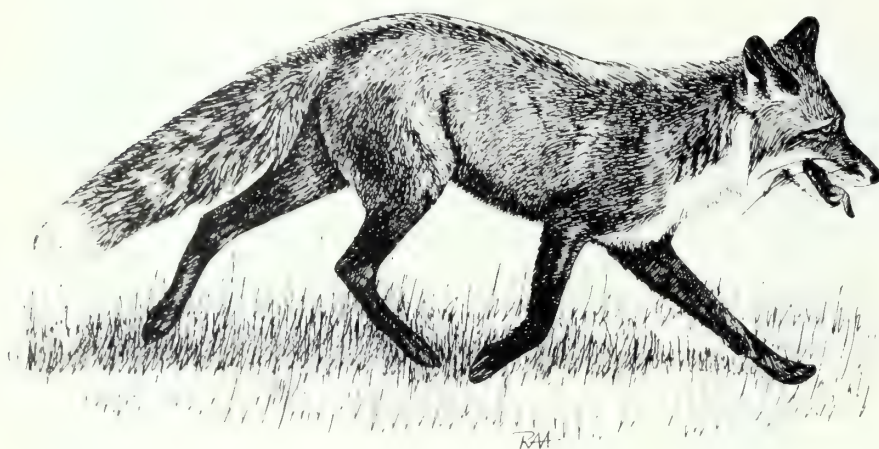
FOOD HABITS: Opportunistic feeders consuming mainly carrion, small live vertebrates, invertebrates, and vegetation. Winter food in the Northeast is mainly snowshoe hare and carrion of deer.

COMMENTS: Mainly crepuscular and nocturnal, hunting alone or in small packs. Den is usually in an excavated burrow that is well hidden by vegetation, a rock, or stump. Dens of other animals frequently used (Bekoff 1982). Several dens may be used by families while pups are less than 10 weeks of age (Harrison and Harrison 1983).

KEY REFERENCES: Banfield 1974; Bekoff 1977, 1978; Hilton 1978; Ozoga and Harger 1966; Stebler 1951.

Red Fox

(*Vulpes vulpes*)



RANGE: North America from Baffin Island s. to c. Texas, excluding se. United States, the West Coast from Canada to California, the sw. desert, and the Great Plains.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Found in a variety of habitats. A mixture of forest and open areas is preferred. Unbroken fields and dense forests avoided. Edges used heavily (Ables 1974).

SPECIAL HABITAT REQUIREMENTS: Suitable den sites.

REPRODUCTION: Age at sexual maturity: Winter after birth. Breeding period: mid-January to late February, sometimes extending to March. Peak: Late January. Gestation period: 51 to 56 days, average 53 days. Young born: March or April. Litter size: 1 to 10, average 4 or 5.

HOME RANGE: Less than 3 miles (4.8 km) in diameter (Ables 1969, Sargeant 1972, Scott 1943, Storm 1965). Phillips and others (1972) found that 70 percent of the juvenile males on study areas in Iowa and Illinois and 30 percent of the females moved more than 5 miles (8 km) from their natal ranges during their first year. Distances of 15 to 20 miles (24 to 32 km) were common. Home range is shared by a male-female pair and seasonally by their pups (Sargeant 1972, Scott 1943). Seven foxes collared in Wisconsin had home ranges from 57.5 to 161.9 ha (142 to 400 acres) (Ables 1969).

FOOD HABITS: Opportunistic feeder consuming animals ranging from insects to small mammals. Commonly takes

birds, turtles, frogs, snakes and their eggs. Berry and fruits are eaten when available. Surplus food is buried or cached under snow and marked with urine. In eastern Maine, Halpin (1983) found snowshoe hares to be the most abundant winter food item in a diet that also included deer and porcupine.

COMMENTS: May dig dens but prefers to use existing burrows for rearing young and escaping predators. Fox dens may have an underground tunnel system 25 to 30 m long or more (Godin 1977:203).

KEY REFERENCES: Godin 1977, Seagears 1944, Scott 1929.

Gray Fox

Urocyon cinereoargenteus)



RANGE: Throughout the United States except Idaho, Montana, Wyoming, most of Washington, and the western U.S. to Texas. Recently extended n. to se. Canada.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon. Presently is reoccupying range in New England.

HABITAT: Dense northern hardwood or mixed forests. Also inhabit thickets and swamps. Prefers a mixture of fields and woods (Wood 1958).

SPECIAL HABITAT REQUIREMENTS: Den sites such as hollow logs, tree cavities, rock crevices, or cavities beneath deserted buildings, rarely in ground burrows.

REPRODUCTION: Age at sexual maturity: First year after birth. Breeding period: Mid-January to May. Peak: Early March (latitude-dependent). Gestation period: 51 to 63 days, average 53 days. Young born: March or April. Litter size: 2 to 7 pups, average 3 to 5 (Wood 1958).

HOME RANGE: Varies with food supply, disturbances, hunting, and season. Range varies from a mile (1.6 km) to 5 miles (8 km) during denning to 5 miles (8 km) in the fall (Godin 1974:206). Yearsley and Samuel (1980) found home ranges from 75 to 185 ha (185 to 457 acres).

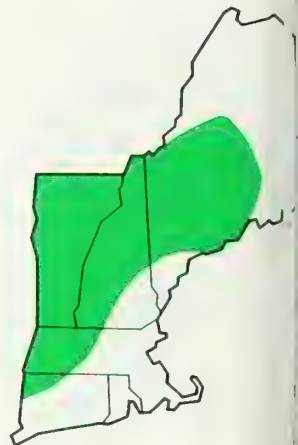
FOOD HABITS: Crepuscular and nocturnal. Chiefly small mammals, particularly cottontails, but includes birds, reptiles and amphibians and their eggs. Acorns, insects, fruit, and carrion are also eaten.

COMMENTS: Hunts prey and escapes enemies by climbing trees. The northward spread corresponds to that of the cottontail.

KEY REFERENCES: Burt and Grossenheider 1976, Godin 1977, Sullivan 1956.

Black Bear

(*Ursus americanus*)



RANGE: Throughout Canada except the n. coast. In the United States it occurs in the Sierras, Idaho, and Montana, s. through the Rockies into Mexico, n. Great Lakes area, Ozarks, Gulf Coast, Florida, and New England s. through the Appalachians to n. Georgia.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common in north to uncommon farther south. Increasingly reported from nw. New Jersey (R. Lund, personal communication.).

HABITAT: Primarily in fairly remote forests and swamps. Prefers mixed deciduous-coniferous woodlands with a thick understory. Requires abundant sources of hard or soft mast within its habitat (Pelton 1982).

SPECIAL HABITAT REQUIREMENTS: Den sites located under fallen trees, in hollow logs, rock ledges, slash piles, or other protected areas.

REPRODUCTION: Age at sexual maturity: Females: 3-1/2 years to 5 years (Pelton 1982). Breeding period: Early June through mid-July. Peak: mid-June. Gestation period: 7 to 8 months, average 220 days. Young born: Mid-January in Pennsylvania (Alt 1981) to February. Litter size: 1 to 5, average 2 (varies with year and locality, females breed once every 2 years).

HOME RANGE: Home range size varies with many factors and is presently unknown. There is probably a greater seasonal range in the male black bear than the female (Godin 1977:209). Most widely accepted range is a 15-

mile (24 km) average radius for adult males and a somewhat smaller radius for females (Cahalane 1947).

FOOD HABITS: Plant material is the major food; forbs and grasses eaten in spring, soft mast (fruit) in summer and hard and soft mass in fall (Pelton 1982). Omnivorous feeder consuming insects, especially grubs and ants under the bark of rotten logs and stumps, mice, frogs, acorns and beechnuts, apples and numerous berries. Also takes carrion and garbage.

COMMENTS: Nocturnal. Trails are used repeatedly and prominent trees are often marked by either sex by climbing and ripping off bark. Several individuals may climb the same tree. Usually solitary except mother and cubs. Cubs are born during the winter while the female is in the den. At birth they weigh less than 1 pound (448 g) and are poorly developed. Females are inactive (semi-hibernation) during the coldest months of the year.

KEY REFERENCES: Banfield 1974, Burt and Grossenheider 1976, Cardoza 1976, Godin 1977, Jonkel and Coven 1971, Spencer 1961.



DISTRIBUTION: Throughout most of s. Canada and the United States except for the deserts of the Southwest and higher elevations of the Rocky Mountains. Also occurs from Mexico to Panama.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

NATURAL HABITAT: Wooded areas interrupted by fields and water bodies. Not usually found in dense forests, commonly found in wetlands near human habitation. Areas where food is available (Kaufman 1982).

IDEAL HABITAT REQUIREMENTS: A den in any protected place from a culvert to an abandoned woodchuck burrow. Raccoons hollow trees. Dens are usually located in trees 10 to 30 m or more above ground (Banfield 1974:314) and are located near water.

REPRODUCTION: Age at sexual maturity: 50 percent of female breed as yearlings (Stuewer 1942); remaining breed when 2 years old. Breeding period: Late January to mid-March, peak in February. Gestation period: 63 to 65 days. Young born: Late April to early May (if female is not fertilized, a second breeding cycle may begin 2 to 4 months later (Whitney and Underwood 1952). Litter size: 3 to 7 cubs, average 2 to 5 (Asdell 1964). Litters per year: 1.

HOME RANGE: The home range is usually between 0.6 and 1.8 miles, 1 and 3 km in diameter (Kaufman 1982). Home range varies with the individual, food availability, and season. Raccoons have traveled up to 165 miles (264 km) in 164 days (Lynch 1967).

SAMPLE DENSITIES: Densities in New Jersey ranged from 1 raccoon per 1.8 ha (4.4 acres) in woodlands near suburban areas, to 1 raccoon per 18.9 ha (47 acres) in mixed forest and agricultural land (Slate et al. 1982).

FOOD HABITS: Omnivorous and opportunistic. Animal matter is the major food in spring and early summer. Fruits and seeds are eaten in summer, fall, and winter. Crayfish, worms, insects, carrion, tender buds and shoots, grass, and garbage are typical foods.

COMMENTS: Primarily nocturnal, may be seen in daylight. Dormant through the winter remaining in dens but not hibernating. An entire family may den together. Raccoons are alert, intelligent animals with a well-developed sense of touch.

KEY REFERENCES: Godin 1977, Hamilton 1936, Lotze and Anderson 1979, Stuewer 1942.

Marten

(*Martes americana*)



RANGE: Boreal forests of Canada to Alaska s. in the Cascade-Sierra Nevada ranges, and the Rockies into New Mexico; extreme n. Minnesota and Wisconsin and n. New England and New York.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon.

HABITAT: A diversity of wooded habitats including coniferous forests of fir, spruce and hemlock, dense mixed hardwood-conifer forests, cedar swamps. Softwood dominated mixed stands preferred in undisturbed forest in Maine (Soutiere 1978). In the Adirondacks martens are found in 30-year-old mixed stands, and in pole and mature hardwood stands at elevations of 530 m to 1463 m (1,740 to 4,800 feet) (Brown 1980).

SPECIAL HABITAT REQUIREMENTS: Den sites (hollow trees or logs are most commonly used). Martens seem to have no permanent den site (Godin 1977:217).

REPRODUCTION: Age at sexual maturity: Females: 2 to 3 years old. Males: 1 year. Breeding period: Mid-summer. Peak: July. Gestation period: 220 to 275 days, 27-day delayed implantation. Young born: Early April to mid-May. Litter size: 1 to 5, typically 3 to 4.

HOME RANGE: Average home range is 1 square mile (2.6 km²) for males and 0.25 square mile (0.65 km²) for females (Godin 1977:218). Recent work in Maine found that home ranges were 5.5 to 23.5 km² (0.7 to 1.1 square miles) for females determined by the modified minimum

area polygon method (Major et al. 1981). Adults have been found to range up to 15 square miles (39 km²) (Clark and Campbell 1977 cited in Strickland et al. 1982). A seasonal altitudinal migration may occur in the mountains (Banfield 1974:316).

FOOD HABITS: Small mammals, especially voles and mice (staples), red squirrels, and chipmunks. Snowshoe hare, grouse, small birds and their eggs, insects and fruits are taken when available, and frogs, toads, reptiles and carrion are also eaten. Active night and day during all seasons. Much of winter hunting is done below snow surface (Clark and Campbell 1977 cited in Strickland et al. 1982).

COMMENTS: Martens are easily trapped, which may partially explain their decline in the Northeast. Loss of habitat through logging, burning and land clearing are factors contributing to the range and population decrease (Godin 1977:217). Soutiere (1978) found clearcut-induced martens use for up to 15 years; adequate habitat was provided in selective timber cuts that maintained pole stage and older residual stand of basal area 20 m²/ha (90 to 110 square feet per acre). Currently being reintroduced in the White Mountain National Forest, New Hampshire. This species is commonly called pine marten.

KEY REFERENCES: Banfield 1974, Burt 1957, Burt and Grossenheider 1976, Godin 1977.



RANGE: Southeastern Labrador w. to se. Alaska s. in the Sierra Nevadas of California and the Rocky Mountains to Wyoming. Also in n. Minnesota, the Adirondacks of New York, and the mountain ranges of New England. It is recolonizing former range in the Northeast.

RELATIVE ABUNDANCE IN NEW ENGLAND: Probably common to uncommon.

HABITAT: Extensive forests of mixed hardwoods and conifers. Found less frequently in more open stands or wooded areas. Favors wetlands (alder) and mixed hardwood-hardwood forest types (Kelly 1977:77). Diverse mixtures of preferred habitats (Strickland et al. 1982).

SPECIAL HABITAT REQUIREMENTS: Dens in hollow trees, ground holes under large boulders, or vacant porcupine dens. Rarely digs burrow. Dens may be lined with leaves and are often used as temporary shelters during winter storms; does not hibernate.

REPRODUCTION: Age at sexual maturity: Both sexes become mature before their 12th month of age. Females produce first litter when 2 years old (Wright and Coulter 1966). Breeding period: Late February to April. Peak: March. Gestation period: 46 to 51 weeks (Hall 1942), with implantation delayed 9 to 10 months; average 51 weeks. Young born: March to early April. Litter size: 1 to 5, average 3.

HOME RANGE: Kelly (1977) found that yearly ranges averaged 4,747 acres (1,922 ha) and monthly ranges averaged 2,794 acres (1,131 ha) in northern New Hampshire.

Home range was from 8 to 15 miles (12.8 to 24.0 km) in diameter (Jackson 1961). Hunting circuits may be 60 miles (96 km) in length (Banfield 1974:319). Males range farther than females. Fishers commonly travel along ridges crossing small streams to reach the next ridge (Coulter 1959).

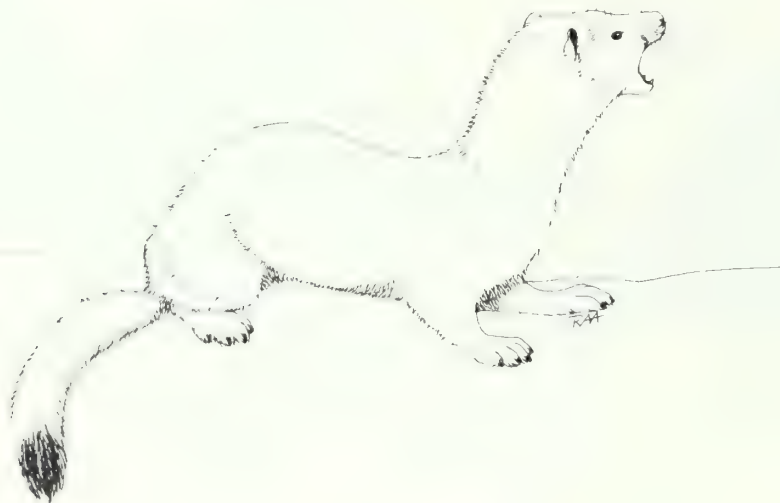
FOOD HABITS: About 80 percent of the fisher's diet is mammals (Banfield 1974:319). They are opportunists taking shrews, mice, squirrels, birds, toads, insects, berries, nuts, and carrion. Procupines are common and preferred prey of fishers.

COMMENTS: Fishers are good climbers and are as agile in trees as on ground. Active both day and night, throughout the year.

KEY REFERENCES: Banfield 1974, Burt 1957, Coulter 1966, Godin 1977, Kelly 1977.

Ermine

(*Mustela erminea*)



RANGE: Throughout Alaska and most of Canada, s. in the United States to s. Pennsylvania and w. Maryland, the Great Lakes region and the nw. quarter of the country.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Wooded or open country with thickets, rock piles or other heavy cover; often close to watercourses.

SPECIAL HABITAT REQUIREMENTS: Small rodents, dense brushy cover.

REPRODUCTION: Age at sexual maturity: Males: Probably 1 year. Females: 3 or 4 months (Jackson 1961:341). Breeding period: July or August. Gestation period: Possibly 9 months (Hamilton 1933b), about 255 days (Jackson 1961:341). Young born: Mid-April to early May. Litter size: 4 to 9, typically 6 or 7.

HOME RANGE: Approximately 30 to 40 acres (12.1 to 16.2 ha) under normal conditions but may extend for 2 or 3 linear miles (3.2 to 4.8 km) per night during periods of food shortage (Jackson 1961:341).

SAMPLE DENSITIES: May reach 20 individuals per square mile (8/km²) in favorable habitat (Jackson 1961:341).

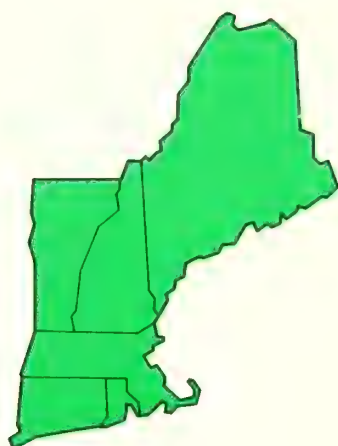
FOOD HABITS: Mice (staple), chipmunks, moles and shrews, occasionally birds and insects, and rarely snakes, frogs, or fish.

COMMENTS: Den is usually below ground under fallen tree or stump but may also be in abandoned building, stone wall, hollow log, or almost anywhere there is a small dry enclosure. Nocturnal and active throughout the year. Molts to white in winter throughout the Northeast. Formerly short-tailed weasel.

KEY REFERENCES: Hall 1951, Hamilton 1933b, Jackson 1961.

Long-tailed Weasel

(*Mustela frenata*)



RANGE: Southern Canada to South America. Not found in the sw. deserts of the United States, nw. Mexico or the Baja Peninsula.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Open woods and woodland edges, grasslands, river bottomlands, fencerows. Found in elevations from sea level to the alpine tundra zone. Prefers to be near water.

SPECIAL HABITAT REQUIREMENTS: Uses previously excavated burrows or natural holes or crevices for dens.

REPRODUCTION: Age at sexual maturity: Females: 3 to 4 months. Males: 1 year. Breeding period: July to August. Gestation period: 205 to 337 days, average 279 days (Wright 1942) (approximately 7-1/2 months delayed implantation). Young born: April to May. Litter size: 1 to 12, average 6 to 9 (Wright 1948).

HOME RANGE: Size varies with food availability, cover type, and season. Studies in Wisconsin showed ranges of 3 to 40 acres (12.1 to 16.2 ha) (Jackson 1961) and in Missouri, 400 acres (162 ha) (Schwartz and Schwartz 1959). About 300 acres (121.5 ha) in mixed agricultural-wooded-marsh habitat in southern Michigan. Average foraging radius was 0.3 miles (0.5 km) from den, and the average daily distance traveled by 1 large male was 2 miles (3.2 km) (Quick 1944).

FOOD HABITS: Primarily small mammals including voles, mice, rabbits, shrews; some birds, especially ground nesting species; a few insects and an occasional snake. Small prey is eaten entirely. May climb trees to catch prey.

COMMENTS: Active year long; commonly thought to be mainly nocturnal but often seen active during daylight hours. Some individuals turn white in winter where climate is cold. Molting occurs from mid-October to mid-November and mid-February to mid-April.

KEY REFERENCES: Banfield 1974, Burt and Grossenheider 1976, Godin 1977, Hall 1951, Hamilton 1933b.

Mink

(*Mustela vison*)



RANGE: Canada (except high Arctic) w. through Alaska and s. throughout the United States (except the sw. deserts).

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Streambanks, lakeshores, and marshes. Favors forested wetlands with abundant cover such as thickets, rocks, or windfalls.

SPECIAL HABITAT REQUIREMENTS: Den sites inside hollow logs, natural cavities under tree roots or in burrows along stream, marsh, or lake edges.

REPRODUCTION: Age at sexual maturity: 10 months. Breeding period: Late February to early April. Peak: March (Mitchell 1961). Gestation period: 40 to 75 days, average 51 days, 30- to 32-day delayed implantation (Enders 1952). Young born: April or May. Litter size: 2 to 10 kits, average 3 to 4.

HOME RANGE: The average range is 2 to 3 miles (3.2 to 4.8 km) in diameter for males along river in Montana. Two females had home ranges of 19.3 and 50.4 acres (7.8 and 20.4 ha) in similar river habitat. Long distance travel is common along waterways, and in winter mink may swim under the ice. Home ranges often overlap between juveniles and adults (Mitchell 1961).

FOOD HABITS: Aquatic and terrestrial prey. Importance of prey items varies with season and habitat (Linscombe et al. 1982). Small mammals, particularly muskrats,

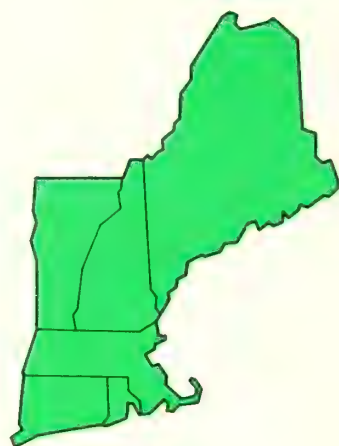
voles, rabbits, fish, frogs, salamanders, crayfish, clams, and insects. Trails prey by scent and often caches food.

COMMENTS: Molts twice a year. Mainly nocturnal, active year long.

KEY REFERENCES: Banfield 1974, Burt and Grossenheider 1976, Godin 1977, Mitchell 1961.

Striped Skunk

(*Mephitis mephitis*)



RANGE: Occurs throughout s. Canada, except coastal British Columbia and throughout the United States except the desert regions of the Southwest.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Semi-open country, woods and meadows, agricultural lands, suburban areas, and trash dumps. Occurs from sea level to timberline.

SPECIAL HABITAT REQUIREMENTS: Dens; may be under logs, stumps, in stone walls, rock cavities, or abandoned burrows.

REPRODUCTION: Age at sexual maturity: Spring following birth (Verts 1967). Breeding period: February to late March. Peak: Mid-February. Gestation period: 62 to 68 days. Young born: Late April to early June. Litter size: 2 to 10 kits, typically 6 or 7.

HOME RANGE: Nightly movements cover 0.25 to 0.50 square miles (0.6 to 1.35 km²) increasing to 4 or 5 square miles (10.4 or 13 km²) at night during breeding season (Schwartz and Schwartz 1959).

POPULATION DENSITIES: 31 skunks per square mile (12/km²) during autumn peak on a 1.13-square-mile (2.93 km²) area of farmland, shrub and wooded ravine habitat in Pennsylvania (Jones 1939). 58 square miles (22/km²) in Michigan on good habitat in Michigan (Burt 1948:149).

FOOD HABITS: Omnivorous diet includes insects, snails, small rodents, birds eggs, fruits, grains, nuts, corn, grasses, buds, berries, garbage, and carrion. In summer diet may be as much as 43 percent insects (Banfield 1974:339).

COMMENTS: Semi-hibernates during the winter months; young may remain in den with mother. Crepuscular or nocturnal, sometimes active during daylight hours. Not efficient burrowers but can excavate dens.

KEY REFERENCES: Banfield 1974, Burt and Grossenheider 1976, Godin 1977, Verts 1967.

River Otter

(*Lutra canadensis*)



RANGE: Throughout all but northernmost portions of Canada and Alaska and in all states of the United States. Does not occur in deserts or treeless regions.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon, but probably more common than sightings and trapping would indicate.

HABITAT: Borders of streams, lakes or other wetlands in forested areas.

SPECIAL HABITAT REQUIREMENTS: Body of water such as stream, pond, lake, river; suitable den sites.

REPRODUCTION: Age at sexual maturity: Possibly 2 years (Hamilton and Eadie 1964). Breeding period: March or April, followed by a 10- or 11-month delayed implantation. Gestation period: 9 to 12 months (Hamilton and Eadie 1964). Young born: March or April. Litter size: 1 to 5, average 2 or 3. Litters per year: 1.

HOME RANGE: 15 or more linear miles (24 km) (Burt and Grossenheider 1976), 20 or 30 linear miles (32 or 48 km) for a pair or male but usually less than 1 mile (1.6 km) for females with young (Jackson 1961:384). Territories maintained within home range (Ertinge 1968).

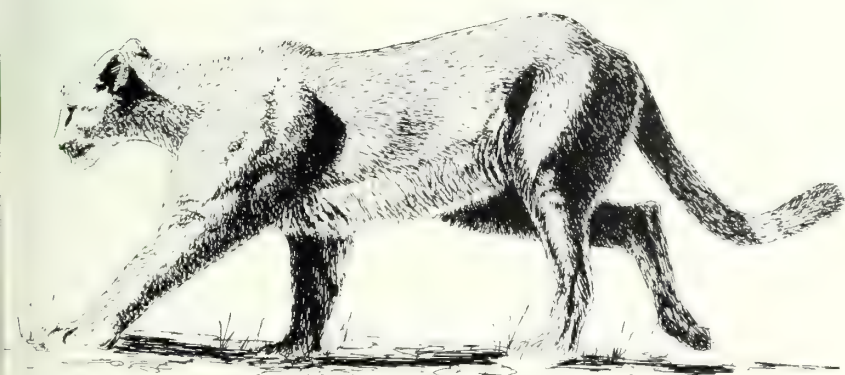
FOOD HABITS: Aquatic animals especially fish, frogs, crayfish, salamanders, and turtles. Also takes snakes, small birds, mammals, earthworms, and insects.

COMMENTS: May be active at any time; dawn to midmorning and evening hours are the periods of most activity (Melquist and Hornocker 1979). Active throughout the year. Den may be in crevice in rocky ledge, under fallen tree, in abandoned beaver lodge or muskrat house or in dense thickets bordering water.

KEY REFERENCES: Jackson 1961, Hamilton and Eadie 1964, Liers 1951.

Mountain Lion

Felis concolor)



RANGE: Southern Canada s. in the w. mountains of the United States to South America, with remnant populations in Florida and possibly New Brunswick.

RELATIVE ABUNDANCE IN NEW ENGLAND: Extirpated. No known breeding population.

HABITAT: Historically used a variety of habitat. If stragglers are present today, they probably inhabit remote mountain forests, swamps, and wooded watercourses.

SPECIAL HABITAT REQUIREMENTS: Isolation from man. Requires abundant supply of deer for prey.

REPRODUCTION: Age at sexual maturity: 2 or 3 years. Feeding period: Throughout the year (every 2 or 3 years). Gestation period: About 3 months. Young born: Throughout the year (spring-born cubs have highest survival rates in the North). Litter size: 1 to 6, typically 2 or 3.

HOME RANGE: May range 20 or 30 linear miles (32 to 48 km) during hunting trips (Hamilton and Whitaker 1979:310). Home ranges in the Northeast are not known. Western home ranges may exceed 30 square miles (78 km²) (Wright 1973). Separate home ranges maintained in summer and winter, following movements of deer and elk (Dixon 1982).

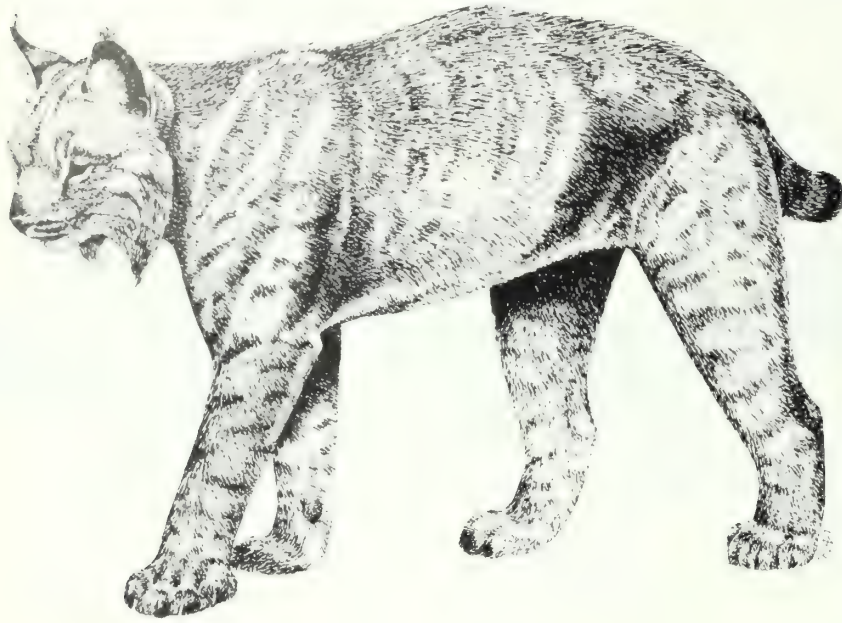
FOOD HABITS: Nocturnal. Feeds on deer, foxes, beavers, porcupine, raccoons, skunks, rabbits, and smaller mammals. Caches large prey.

COMMENTS: There is little if any evidence of a breeding population in the northeastern United States. A sparse population may exist in the southeastern states although evidence is not clear. There is a small population in Florida (Dixon 1982). Many unconfirmed sightings in New England and one confirmed track cast (R. Downing, personal communication). Some stragglers may be escapees from zoos or others may be kept illegally as pets. Also called the cougar.

KEY REFERENCES: Hamilton and Whitaker 1979, Young and Goldman 1946.

Lynx

(*Felis lynx*)



RANGE: Newfoundland w. to Yukon Territory and Alaska s. in the United States to n. Oregon, n. Wisconsin, and n. New England.

RELATIVE ABUNDANCE IN NEW ENGLAND: Uncommon to rare.

HABITAT: Interiors of extensive, unbroken forests well removed from human activity. Favors swamps, bogs, or rocky areas. Selected successional habitat on Cape Breton Island (Parker 1982).

SPECIAL HABITAT REQUIREMENTS: Secluded den sites, extensive forests.

REPRODUCTION: Age at sexual maturity: 1 year, may vary with prey abundance (McCord and Cardoza 1982). Breeding period: January to February. Gestation period: About 62 days. Young born: May to early June. Litter size: 1 to 4. Litters per year: 1.

HOME RANGE: About 5 square miles (13 km²) during breeding season (Burt and Grossenheider 1976). 6 to 8 square miles (16 to 21 km²) with 2.6-mile (4.2-km) daily cruising radius (Banfield 1974:350). Adult home ranges were larger in summer 25 to 32 km² (9.6 to 12.3 square miles) than winter 12 to 18 km² (4.6 to 6.9 square miles) on Cape Breton Island. Cruising distance was 9 km (5.6 miles) in summer and 8 km (4.9 miles) in winter (Parker 1982).

FOOD HABITS: Mainly snowshoe hare (staple), rodents, and birds. Occasionally carrion of deer or caribou. Lynx

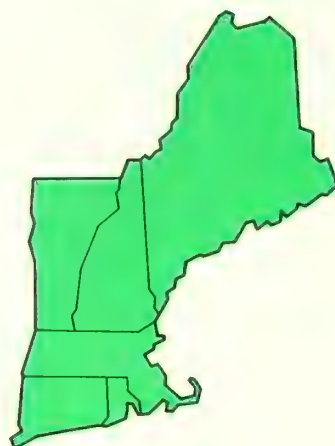
populations fluctuate with snowshoe hare abundance, reaching peak numbers about once every 10 years.

COMMENTS: Mainly nocturnal and solitary; active throughout the year. Rears young in den which may be among rocks, under fallen tree, in a hollow log, or other sheltered place.

KEY REFERENCES: Banfield 1974, Godin 1977, Saunders 1963a, 1963b, Siegler 1971.

Bobcat

(*Felis rufus*)



RANGE: Southern Canada s. throughout the w. half of the United States and through the e. uplands and mountains. Also occurs along the Gulf Coast and in Florida. Reintroduced to n. New Jersey in 1978 Lund 1980).

RELATIVE ABUNDANCE IN NEW ENGLAND: Common to uncommon.

HABITAT: Mixed deciduous-coniferous and hardwood forests and brushy and rocky woodlands broken by fields, old roads and farmland. Frequently found in cedar swamps and spruce thickets. Favors areas with thick undergrowth. Softwood cover preferred in winter (May 1982).

SPECIAL HABITAT REQUIREMENTS: Rocky ledges critical in Massachusetts (McCord and Cardoza 1982). Prefers to den in rock crevices, under windfalls, or in hollow logs. The den is usually lined with dried grasses, leaves, and moss.

REPRODUCTION: Age at sexual maturity: Females mature within a year after birth. Males mature during second year (Crowe 1975). Breeding period: Late February to March, sometimes extending into June. Gestation period: About 62 days. Young born: Late April to mid-May. Litter size: 1 to 4 kittens, average 2. Litters per year: Second litter sometimes born in early August. May be regularly polyestrous in the southern portion of the range (Enfield 1974:353).

HOME RANGE: 2 to 5 linear miles (3.2 to 8 km) for nightly travel in Massachusetts (Pollack 1951). McCord (1977) estimated 26 to 31 acres (10.5 to 12.5 ha) in Massachusetts. In Maine, mean annual home range was 23 km² (8.9 square miles), winter ranges were 30 percent larger than summer ranges (May 1982). In the Catskills, home range was approximately 36 km² (14 square miles) for males and 31.0 km² (12 square miles) for females; Adirondack ranges were estimated to be 325 km² (125 square miles) for males and 86 km² (33 square miles) for females (Fox and Brocke 1983). Ranges farther to find mates or follow prey. In Minnesota, Bobcats traveled 3 to 7 miles (4.8 to 11.2 km) while hunting (Rollings 1945).

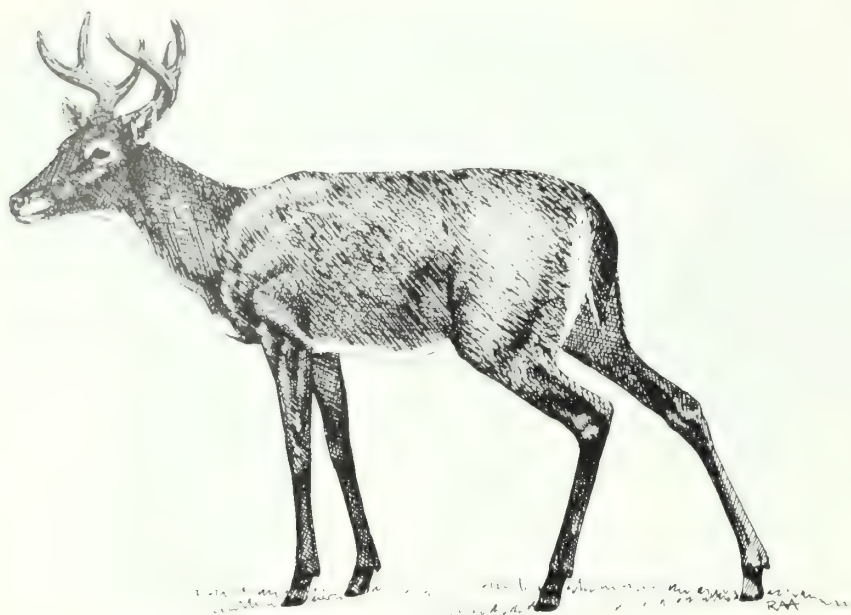
FOOD HABITS: Small mammals, especially snowshoe hare, cottontails, squirrels, mice, birds and their eggs. deer is a principal winter diet component in New York (Fox and Brocke 1983). Carrion (untainted), snakes, fish, crustaceans, insects, and some vegetation are also eaten. Most prey is taken by stalking.

COMMENTS: Favors established routes and uses scent posts. Solitary and elusive, mainly nocturnal but in winter is active during daylight. Avoids crossing bodies of water (generally) but can swim well (Godin 1977:241).

KEY REFERENCES: Banfield 1974, Godin 1977, McCord 1974, Rollings 1945, Siegler 1971.

White-tailed Deer

(*Odocoileus virginianus*)



RANGE: Across s. Canada to c. British Columbia and throughout the United States, except for most of California, Nevada, Utah, and w. Colorado. Range extends into South America.

RELATIVE ABUNDANCE IN NEW ENGLAND: Common.

HABITAT: Forest edges, swamp borders, areas interspersed with fields and woodland openings. During winter months when snow depth exceeds 16 inches (40.6 cm) Deer will "yard" in stands of conifers, forming a central resting area with trails packed through the snow.

SPECIAL HABITAT REQUIREMENTS: Dense cover for winter shelter, adequate browse.

REPRODUCTION: Age at sexual maturity: Some females mate as yearlings, most males and females are mature at 18 months. Breeding period: Late October to mid-December. Peak: November. Gestation period: 201 days. Young born: May and June with an extreme spread from March to September. Litter size: 1 to 4 fawns, average 2.

HOME RANGE: 2 to 3 square miles (5.2 to 7.8 km²). Size depends on the quality of the habitat. Home range is from 40 acres (16.2 ha) in excellent habitat to 300 acres (121.5 ha) in poor habitat (Banfield 1974:392).

FOOD HABITS: Mainly crepuscular. Deer browse on a variety of woody deciduous plants and some coniferous growth, feeding on twigs and stripping young bark. Also graze on grasses, herbs and mushrooms, and grub for roots. Adaptable in its food habits.

COMMENTS: Gregarious, usually forming small groups. Family groups consisting of a doe with her fawns and yearlings are (sometimes) common in the late fall.

KEY REFERENCES: Banfield 1974, Godin 1977, Taylor 1956.



RANGE: Alaska, the s. half of Canada, n. New England and the n. Rockies into Utah.

RELATIVE ABUNDANCE IN NEW ENGLAND: Locally common and uncommon.

HABITAT: Second-growth boreal forests interspersed with semi-open areas and swamps or lakes that offer cover and aquatic plants for food. Climax stands of balsam fir, white birch, and aspen seral stands are preferred habitat. Summers are spent near water; winters in drier hardwood-conifer forests.

SPECIAL HABITAT REQUIREMENTS: Wetlands preferred in summer for relief from mosquitos and flies and for aquatic plant food items.

REPRODUCTION: Age at sexual maturity: Some females mature at 16 months and produce young in their second year (Peterson 1955:99). Most males probably mature at 1-1/2 years but are unable to breed until 5 or 6 years old due to competition from older bulls. Breeding season: Early September to late October. Peak: Mid-September. Gestation period: 240-246 days. Young born: Late May to early June. Litter size: 1, rarely 2.

HOME RANGE: Probably a radius of 2 to 10 miles (3.2 to 16 km²) if adequate year-round food supply is available (Peterson 1955:113). Seasonal home ranges of 5 to 10 km² (2 to 10 square miles) throughout North America (LeResche 1994). In an area with 5- to 50-year-old patch clearcuts in northern Maine, the home range of females was 11 to 43

km² in summer and 3.37 km² in winter (Crossley and Gilbert 1983). Bulls will range farther during breeding season.

SAMPLE DENSITIES: In Eastern North America, the average density is 1 moose per 5 square miles (13 km²) over much of its range; 2 or more moose per square mile (0.8/km²) approaches carrying capacity (Peterson 1955:202).

FOOD HABITS: During summer they prefer to feed in or near clearings, burns or shoreline areas where they browse on tender leaves, twigs and bark of deciduous trees, and semi-aquatic and aquatic vegetation. They also graze on grasses, lichens, mosses, mushrooms, and herbaceous plants. Winter diet is restricted to conifer (especially balsam fir) and hardwood twigs.

COMMENTS: Populations are increasing in Maine and northern New Hampshire. Moose in mountainous regions generally seek lower elevations in autumn (Edwards and Ritcey 1956). They may gather together in yards during winter and congregate in lily ponds during summer months but are mainly solitary animals. They are most active at dawn and dusk.

KEY REFERENCES: Banfield 1974, Godin 1977, Murie 1934, Peterson 1955.

Literature Cited

- Ables, E. D. Home range studies of red foxes *Vulpes vulpes*. *Journal of Mammalogy*. 50(1): 108-120; 1969.
- Ables, E. D. Ecology of the red fox in North America. In: Fox, M. W., ed. *The wild canids*. New York: Van Nostrand Reinhold Co.; 1974: 148-163.
- Adams, L. An analysis of a population of snowshoe hares in northwestern Montana. *Ecological Monographs*. 29: 141-170; 1959.
- Aldous, C. M. Notes on the life history of the snowshoe hare. *Journal of Mammalogy*. 18(1): 46-57; 1937.
- Allen, E. G. The habits and life history of the eastern chipmunk (*Tamias striatus lysteri*). *New York State Museum Bulletin*. 314: 1-122; 1938.
- Allen, J. M. Gray and fox squirrel management in Indiana. *Pittman-Robertson Bulletin*. Indianapolis, IN: Indiana Department of Conservation; 1954: 1: 1-112.
- Alt, G. L. Reproductive biology of black bears in northeastern Pennsylvania. *Transactions Northeast Section Wildlife Society*. 38: 88-89; 1981.
- Anthony, E. L.; Kunz, T. H. Feeding strategies of the little brown bat, *Myotis lucifugus*, in southern New Hampshire. *Ecology*. 58: 755-786; 1977.
- Arlton, A. V. An ecological study of the common mole. *Journal of Mammalogy*. 17: 349-371; 1936.
- Asdell, S. A. Patterns of mammalian reproduction. 2nd ed. Ithaca, NY: Cornell University Press; 1964. 670 p.
- Bailey, V. Breeding, feeding and other life habits of meadow mice *Microtus*. *Journal of Agricultural Research*. 27(8): 523-536; 1924.
- Banfield, A. W. F. *The mammals of Canada*. Toronto, ON: University of Toronto Press; 1974. 438 p.
- Barbour, R. W.; Davis, W. H. *Bats of America*. Lexington, KY: University of Kentucky Press; 1969. 286 p.
- Bekoff, M. *Canis Latrans*. *Mammalian Species*. Shippenburg, PA: American Society of Mammalogists; 1977; 79: 1-9.
- Bekoff, M., ed. *Coyotes: biology, behavior and management*. New York: Academic Press; 1978. 384 p.
- Bekoff, M. Coyote. In: Chapman, J. A.; Fedlhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 447-459.
- Bekoff, M.; Wells, M. C. Social ecology and behavior of coyotes. *Scientific American*. 242: 130-148; 1980.
- Benton, A. H. Observations on the life history of the northern pine mouse. *Journal of Mammalogy*. 36(1): 52-62; 1955.
- Berg, W. E.; Chesness, R. A. Ecology of coyotes in northern Minnesota. In: Bekoff, M., ed. *Coyotes: Biology, behavior and management*. New York: Academic Press; 1978: 229-247.
- Beule, J. D.; Studholme, A. T. Cottontail rabbit nests and nestlings. *Journal of Wildlife Management*. 6: 133-140; 1942.
- Bider, J. R. An ecological study of the hare (*Lepus americanus*). *Canadian Journal of Zoology*. 39(1): 81-103; 1961.
- Bishop, S. C. Curious behavior of a hoary bat. *Journal of Mammalogy*. 28(3): 293-294; 1947.
- Blair, W. F. Notes on home ranges and populations of the short-tailed shrew. *Ecology*. 21: 284-288; 1940a.
- Blair, W. F. Home ranges and populations of the meadow vole in southern Michigan. *Journal of Wildlife Management*. 4: 149-161; 1940b.
- Blair, W. F. Home ranges and populations of the jumping mouse. *American Midland Naturalist*. 24(3): 244-250; 1940c.
- Blair, W. F. Some data on the home ranges and general life history of the short-tailed shrew, red-bellied mouse and woodland jumping mouse in northern Michigan. *American Midland Naturalist*. 25(3): 681-685; 1941.
- Blair, W. F. Size of home range and notes on the life history of the woodland deer mouse and eastern chipmunk in northern Michigan. *Journal of Mammalogy*. 23(1): 27-36; 1942.
- Bogan, M. A. Observations on parurition and development in the hoary bat (*Lasiurus cinereus*). *Journal of Mammalogy*. 53(3): 611-614; 1972.
- Brower, J. E.; Cade, T. J. Ecology and physiology of *Peromyscus insignis* Miller and other woodland mice. *Ecology*. 47: 46-63; 1966.
- Brown, M. K. The status of the pine marten in New York. *Transactions Northeast Section Wildlife Society*. 21: 217-226; 1980.
- Buckner, C. H. Home range of *Synaptomys cooperi*. *Journal of Mammalogy*. 38(1): 132; 1957.
- Buckner, C. H.; Ray, D. G. H. Notes on the water shrew in bog habitats of southeastern Manitoba. *Blue Jay*. 26(2): 95-96; 1968.
- Burt, W. H. Territorial behavior and populations of some small mammals in southern Michigan. *University of Michigan, Miscellaneous Publications of the Museum of Zoology*. 45: 1-58; 1940.
- Burt, W. H. *Mammals of Michigan*. Ann Arbor, MI: University of Michigan Press; 1948. 288 p.
- Burt, W. H. *Mammals of the Great Lakes Region*. Ann Arbor, MI: University of Michigan Press; 1957. 26 p.
- Burt, W. H.; Grossenheider, R. P. *A field guide to the mammals*. 3d ed. Boston, MA: Houghton Mifflin Co.; 1976. 289 p.
- Cagle, F. R.; Cockrum, L. Notes on a summer colony of *Myotis lucifugus lucifugus*. *Journal of Mammalogy*. 24(4): 474-492; 1943.
- Cahalane, V. H. *Mammals of North America*. New York: Macmillan Co.; 1947. 682 p.
- Calhoun, J. B. *The ecology and sociology of the Norway rat*. Public Health Service Publication. 1008: 1-22; 1962.

- ameron, A. W. Mammals of the islands in the Gulf of St. Lawrence. National Museum of Canada Bulletin. No. 154: 1-165; 1958.
- ardoza, J. The history and status of the black bear in Massachusetts and adjacent New England states. Massachusetts Division of Fish and Wildlife Research Bulletin No. 18: 1-113; 1976.
- hamberlain, J. L. The life history and management of the muskrat on Great Meadows Refuge. Amherst, MA: University of Massachusetts; 1951. 68 p. M.S. thesis.
- hapman, J. A.; Harman, A. L.; Samuel, D. E. Reproductive and physiological cycles in the cottontail complex in western Maryland and nearby West Virginia. Wildlife Monographs No. 56: 1-73; 1977.
- hapman, J. A.; Hockman, J. G.; Edwards, W. R. Cottontails. In: Chapman, J. A.; Feldhamer, G. A. Wild mammals of North America: Biology, management, and economics. Baltimore, MD: Johns Hopkins University Press; 1982: 83-123.
- hoate, J. R. Identification and recent distribution of white-footed mice (*Peromyscus*) in New England. Journal of Mammalogy. 54(1): 41-49; 1973.
- ockrum, E. L. Mammals of Kansas. University of Kansas Publication of the Museum of Natural History. 7: 1-303; 1952.
- onaway, C. H. Life history of the water shrew (*Sorex palustris navigator*). American Midland Naturalist. 48(1): 219-248; 1952.
- onaway, C. H.; Pfitzer, D. W. *Sorex palustris* and *Sorex dispar* from the Great Smoky Mountains National Park. Journal of Mammalogy. 33(1): 106-108; 1952.
- onnor, P. F. The bog lemming *Synaptomys cooperi* in southern New Jersey. Publication of the Museum Michigan State University Biological Series. 1: 161-248; 1959.
- onstantine, D. G. Ecological observations on Lasiurine bats in Iowa. Journal of Mammalogy. 47(1): 34-41; 1966.
- ostello, D. F. The world of the porcupine. Philadelphia, PA: J. B. Lippincott Co.; 1966.
- ulter, M. W. Some recent records of martens in Maine. Maine Field Naturalist 15(2): 50-53; 1959.
- ulter, M. W. Ecology and management of fishers in Maine. Syracuse, New York: Syracuse University; 1966. Ph.D. dissertation.
- owan, I. McT. Nesting habits of the flying squirrel (*Glaucomys sabrinus*). Journal of Mammalogy. 17(1): 58-60; 1936.
- owan, I. McT.; Guiguet, C. J. The mammals of British Columbia. British Columbia Provincial Museum Publication No. 11: 1-141; 1965.
- iddle, S. The red-backed vole (*Clethrionomys raphanistrum* Bailey) in southern Manitoba. Canadian Field-Naturalist. 46(8): 178-181; 1932.
- Crossley, A.; Gilbert, J. R. Home range and habitat use of female moose in northern Maine. Transactions Northeast Section Wildlife Society. 40: 67-75; 1983.
- Crowe, D. M. Aspects of aging, growth and reproduction of bobcats in Wyoming. Journal of Mammalogy. 56(1): 177-198; 1975.
- Curtis, J. D.; Kozicky, E. L. Observations on the eastern popcupine. Journal of Mammalogy. 25(2): 137-146; 1944.
- Dalke, P. D. The cottontail rabbits in Connecticut. Connecticut Geological and Natural History Survey Bulletin. No. 65: 1-97; 1942.
- Dalke, P. D.; Sime, P. R. Home and seasonal ranges of the eastern cottontail in Connecticut. Transactions North American Wildlife Conference. 3: 659-669; 1938.
- Davis, D. W. The characteristics of rat populations. Quarterly Review of Biology. 28(4): 373-401; 1953.
- Davis, W. H.; Hitchcock, H. B. Biology and migration of the bat, *Myotis lucifugus*, in New England. Journal of Mammalogy. 46(2): 296-313; 1965.
- Davis, W. H.; Mumford, R. E. Ecological notes on the bat (*Pipistrellus subflavus*). American Midland Naturalist. 68(2): 394-398; 1962.
- Dean, P. B.; DeVos, A. The spread and present status of the European hare (*Lepus europaeus hybridus*) in North America. Canadian Field-Naturalist. 79(1): 38-48; 1965.
- Dixon, K. R. Mountain lion. In: Chapman, J. A.; Feldhamer, G. A., eds. Wild mammals of North America: Biology, management, and economics. Baltimore, MD: Johns Hopkins University Press; 1982: 711-727.
- Dodds, D. G. Reproduction and productivity of snowshoe hares in Newfoundland. Journal of Wildlife Management. 29: 303-315; 1965.
- Dodge, W. E. The biology and life history of the porcupine, *Erethizon dorsatum*, in western Massachusetts. Amherst, MA: University of Massachusetts; 1967. Ph.D. dissertation.
- Dodge, W. E. Porcupine. In: Chapman, J. A.; Feldhamer, G. A., eds. Wild mammals of North America: Biology, management, and economics. Baltimore, MD: Johns Hopkins University Press; 1982: 355-366.
- Doebel, J.; McGinnis, B. Home range and activity of a gray squirrel population. Journal of Wildlife Management. 38: 860-867; 1974.
- Dolan, P. G.; Carter, D. C. *Glaucomys volans*. Mammalian Species. Shippensburg, PA: American Society of Mammalogists; 1977; 78: 1-6.
- Druecker, J. D. Aspects of reproduction in *Myotis volans*, *Lasionycteris noctivagans* and *Lasiurus cinereus*. Dissertation Abstracts. 33B(10): 5065; 1972.
- Eabry, H. S. A feasibility study to investigate and evaluate the possible directions of European hare management in New York. Delmar, New York: New York Department of Environmental Conservation; 1970. Federal Aid Pittman-Robertson Project W-84-R17.

- Eadie, W. R. A contribution to the biology of *Parascalops breweri*. Journal of Mammalogy. 20(2): 150-173; 1939.
- Eadie, W. R.; Hamilton, W. J., Jr. Notes on reproduction in the star-nosed mole. Journal of Mammalogy. 37(2): 223-231; 1956.
- Edwards, R. Y.; Ritcey, R. W. The migrations of a moose herd. Journal of Mammalogy. 37(4): 486-494; 1956.
- Elliott, L. Social behavior and foraging ecology of the eastern chipmunk (*Tamias striatus*) in the Adirondack Mountains. Smithsonian Contribution to Zoology No. 265: 1-107; 1978.
- Elton, C.; Nicholson, M. Fluctuations in numbers of muskrat (*Ondatra zibethica*) in Canada. Journal of Animal Ecology. 11(1): 96-126; 1942.
- Enders, R. K. Reproduction in the mink. Proceedings of the American Philosophical Society. 96(6): 691-755; 1952.
- Erlinge, S. Territoriality of the otter, *Lutra lutra* L. Oikos. 19(1): 81-98; 1968.
- Errington, P. L. Muskrats and marsh management. Lincoln, NE: Wildlife Management Institute, University of Nebraska Press; 1961. 183 p.
- Errington, P. L. Muskrat populations. Ames, IA: Iowa State University Press; 1963. 655 p.
- Errington, P. L.; Errington, C. S. Experimental tagging of young muskrats for purposes of study. Journal of Wildlife Management. 1: 49-61; 1937.
- Fall, M. W. Seasonal variations in the food consumption of woodchucks, *Marmota monax*. Journal of Mammalogy. 52(2): 370-375; 1971.
- Faulkner, C. E.; Dodge, W. E. Control of the porcupine in New England. New Hampshire's Conservation Magazine. 72: 9-10, 18; 1962.
- Fay, F. H.; Chandler, E. H. The geographical and ecological distribution of cottontail rabbits in Massachusetts. Journal of Mammalogy. 36(3): 415-424; 1955.
- Fitch, J. H.; Shump, K. A., Jr. *Myotis keenii*. Mammalian Species. Shippensburg, PA: American Society of Mammalogists; 1979; 121: 1-3.
- Flyger, V. F. Movements and home ranges of the gray squirrel (*Sciurus carolinensis*) in two Maryland woodlots. Ecology. 41: 365-369; 1960.
- Forbes, R. B. Studies of the biology of Minnesotan chipmunks. American Midland Naturalist. 76: 290-308; 1966.
- Fox, L. B.; Brocke, R. H. Ecology and demography of a northern winter stressed bobcat population. Transactions Northeast Section Wildlife Society. 40: 98; 1983.
- Francq, E. N. Behavioral aspects of feigned death in the opossum (*Didelphis marsupialis*). American Midland Naturalist. 81(2): 556-568; 1969.
- French, N. R.; McBride, R.; Detmer, J. Fertility and population densities of the black-tailed jackrabbit. Journal of Wildlife Management. 29: 14-26; 1965.
- Getz, L. L. Factors influencing the local distribution of shrews. American Midland Naturalist. 65: 67-8; 1961a.
- Getz, L. L. Home ranges, territoriality and movement of the meadow vole. Journal of Mammalogy. 42(1): 33-36; 1961b.
- Godin, A. J. Wild mammals of New England. Baltimore, MD: Johns Hopkins University Press; 1977. 304 p.
- Griffin, D. R. Migrations of New England bats. Harvard University Museum of Comparative Zoology Bulletin. 86: 217-246; 1940a.
- Griffin, D. R. Notes on the life histories of New England cave bats. Journal of Mammalogy. 21(2): 181-188; 1940b.
- Griffin, D. R. Travels of banded cave bats. Journal of Mammalogy. 26(1): 15-23; 1945.
- Grizzell, R. A., Jr. A study of the southern woodchuck, *Marmota monax monax*. American Midland Naturalist. 53(2): 257-293; 1955.
- Hall, E. R. Gestation period of the fisher with recommendations for the animal's protection in California. California Fish Game. 28: 143-147; 1942.
- Hall, E. R. *Mustela erminea*. In: American weasels. University of Kansas Publ. Museum of Natural History. 4: 87-167; 1951.
- Hall, J. S. Life history studies of the eastern pipistrelle (*Pipistrellus subflavus*) in Massachusetts. Amherst, MA: University of Massachusetts; 1956. 74 p. M.S. thesis.
- Hall, J. S. A life history and taxonomic study of Indiana bat, *Myotis sodalis*. Urbana, IL: University of Illinois; 1960. 135 p. Ph.D dissertation.
- Hall, J. S. A life history and taxonomic study of the diana bat, *Myotis sodalis*. Reading, PA: Public Museum and Art Gallery; 1962; Sci. Publ. No. 12. 68 p.
- Hallett, J. G. *Parascalops breweri*. Mammalian Species. Shippensburg, PA: American Society of Mammalogists; 1978; 98: 1-4.
- Halpin, M.; Bissonette, J. Winter resource use by raccoons in eastern Maine. Transactions Northeast Section Wildlife Society. 40: 158; 1983.
- Hamilton, W. J., Jr. Habits of the short-tailed shrew (*Blarina brevicauda* Say). Ohio Journal of Science. 31(2): 97-106; 1931a.
- Hamilton, W. J., Jr. Habits of the star-nosed mole (*Condylura cristata*). Journal of Mammalogy. 12(4): 353-355; 1931b.
- Hamilton, W. J., Jr. The insect food of the big brown bat. Journal of Mammalogy. 14(2): 155-156; 1933a.
- Hamilton, W. J., Jr. The weasels of New York: Their natural history and economic status. American Midland Naturalist. 14(4): 289-344; 1933b.
- Hamilton, W. J., Jr. Habits of jumping mice. American Midland Naturalist. 16(1): 187-200; 1935.
- Hamilton, W. J., Jr. The food and breeding habits of the raccoon. Ohio Journal of Science. 36: 131-136; 1936.

- Hamilton, W. J., Jr. Activity and home range of the field mouse, *Microtus pennsylvanicus pennsylvanicus* Ord. Ecology. 18: 255-263; 1937.
- Hamilton, W. J., Jr. Life history notes on the northern pine mouse. Journal of Mammalogy. 19(2): 163-170; 1938.
- Hamilton, W. J., Jr. Activity of Brewer's mole (*Parasclops breweri*). Journal of Mammalogy. 20(3): 307-310; 1939a.
- Hamilton, W. J., Jr. Observations on the life history of the red squirrel in New York. American Midland Naturalist. 22(3): 732-745; 1939b.
- Hamilton, W. J., Jr. The biology of the smoky shrew (*Sorex fumeus fumeus* Miller). Zoologica. 25(4): 473-492; 1940.
- Hamilton, W. J., Jr. Reproduction of the field mouse (*Microtus pennsylvanicus* Ord). Cornell University Agriculture Experiment Station Memoirs. 237: 1-23; 1941.
- Hamilton, W. J., Jr. The biology of the little short-tailed shrew (*Cryptotis parva*). Journal of Mammalogy. 25(1): 1-7; 1944.
- Hamilton, W. J., Jr. The food of the opossum in New York State. Journal of Wildlife Management. 15: 258-264; 1951.
- Hamilton, W. J., Jr. Life history and economic relations of the opossum (*Didelphis marsupialis virginiana*) in New York State. Cornell University Agriculture Experiment Station Mem. 354: 1-48; 1958.
- Hamilton, W. J., Jr.; Eadie, W. R. Reproduction in the otter (*Lutra canadensis*). Journal of Mammalogy. 45(2): 242-252; 1964.
- Hamilton, W. J., Jr.; Whitaker, J. O., Jr. Mammals of the eastern United States. Ithaca, NY: Cornell University Press; 1979. 346 p.
- Harrison, D. J.; Harrison, J. A. Denning ecology, movements, and dispersal of coyotes in eastern Maine. Transactions Northeast Section Wildlife Society. 40: 108; 1983.
- Hartman, C. G. Breeding habits, development and birth of the opossum. In: Smithsonian Report for 1921. Washington, DC: Smithsonian Institute; 1953: 347-363.
- Harvey, M. J. Home range, movements and daily activity of the eastern mole (*Scalopus aquaticus*). Lexington, KY: University of Kentucky; 1967. 78 p. Ph.D. dissertation.
- Hatt, R. T. The red squirrel: Its life history and habits. Bull. New York College Forestry. Roosevelt Wild Life Annals 2(1): 1-140; 1929.
- Haugen, A. O. Life history studies of the cottontail rabbit in southwestern Michigan. American Midland Naturalist. 28(1): 204-244; 1942.
- Hill, B. J. Small mammal habitat associations in selected timbered community types on the White Mountain National Forest, New Hampshire. Amherst, MA: University of Massachusetts; 1982. 140 p. M.S. thesis.
- Hilton, H. Systematics and ecology of the eastern coyote. In: Bekoff, M., ed. Coyotes: Biology, behavior and management. New York: Academic Press; 1978. 384 p.
- Hiner, L. E. Observations on the foraging habits of beavers. Journal of Mammalogy. 19(3): 317-319; 1938.
- Hitchcock, H. B. Hibernation of bats in southeastern Ontario and adjacent Quebec. Canadian Field-Naturalist. 63(2): 47-59; 1949.
- Hitchcock, H. B. A summer colony of the least bat, *Myotis subulatus leibii* (Audubon and Bachman). Canadian Field-Naturalist. 69(2): 31; 1955.
- Hodgdon, H. E.; Larson, J. S. Some sexual differences in behavior within a study of marked beavers (*Castor canadensis*). Animal Behavior. 21(1): 147-152; 1973.
- Huey, W. C. New Mexico beaver management. New Mexico Department Game and Fish Bulletin. 4: 1-49; 1956.
- Humphrey, S. R. Status, winter habitat and management of the endangered Indiana bat, *Myotis sodalis*. Florida Science. 41(2): 65-76; 1978.
- Humphrey, S. R. Bats. In: Chapman, J. A.; Feldhamer, G. A., eds. Wild mammals of North America: Biology, management, and economics. Baltimore, MD: Johns Hopkins University Press; 1982: 52-70.
- Humphrey, S. R.; Cope, J. B. Population ecology of the little brown bat, *Myotis lucifugus*, in Indiana and north-central Kentucky. Special Publication. Shippensburg, PA: American Society of Mammalogists; 1976; 4: 1-81.
- Humphrey, S. R.; Richta, A. R.; Cope, J. B. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. Journal of Mammalogy. 58(3): 334-346; 1977.
- Ickes, R. A. Agonistic behavior and the use of space in the eastern chipmunk, *Tamias striatus*. Pittsburgh, PA: University of Pittsburgh; 1974. Ph.D. dissertation.
- Jackson, H. H. T. Mammals of Wisconsin. Madison, WI: University of Wisconsin Press; 1961. 504 p.
- Jenkins, S. H.; Busher, P. E. *Castor canadensis*. Mammalian Species. Shippensburg, PA: American Society of Mammalogists; 1979; 120: 1-8.
- Johnson, C. E. The muskrat in New York: Its natural history and economics. Roosevelt Wild Life Bulletin. 3: 199-320; 1925.
- Johnston, J. E. Identification and distribution of cottontail rabbits in southern New England. Storrs, CT: University of Connecticut; 1972. M.S. thesis.
- Jones, H. W., Jr. Winter studies of skunks in Pennsylvania. Journal of Mammalogy. 20(2): 254-256; 1939.
- Jones, J. Knox, Jr.; Carter, Dillard C.; Genoways, Hugh W.; Hoffman, Robert S.; Rice, Dale W. Revised checklist of North American mammals north of Mexico, 1982. Occasional Papers Museum Texas Tech University. 80: 1-22; 1982.

- Jonkel, C. J.; I. McT. Cowan. The black bear in the spruce-fir forest. *Wildlife Monographs*. 27: 1-57; 1971.
- Jordan, J. S. A midsummer study of the southern flying squirrel. *Journal of Mammalogy*. 29(1): 44-48; 1948.
- Kaufman, J. H. Raccoon and allies. In: Chapman, J. A.; Feldhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 567-585.
- Kelly, G. M. Fisher (*Martes pennanti*). Biology in the White Mountains National Forest and adjacent areas. Amherst, MA: University of Massachusetts; 1977. Ph.D. dissertation.
- King, J. A., ed. *Biology of Peromyscus* (Rodentia). Special Publication. Shippensburg, PA: American Society of Mammalogists; 1968; 2. 593 p.
- Kirkland, G. L., Jr. The rock vole, *Microtus chrotorrhinus* Miller (Mammalia: Rodentia), in West Virginia. *Annals Carnegie Museum* No. 46(5): 45-53; 1977a.
- Kirkland, G. L., Jr. Responses of small mammals to the clearcutting of northern Appalachian forests. *Journal of Mammalogy*. 58(4): 600-609; 1977b.
- Kirkland, G. L., Jr. Responses of small mammals to the clearcutting of northern Appalachian forests. *Journal of Mammalogy*. 58(4): 600-609; 1977b.
- Kirkland, G. L., Jr. Initial responses of small mammals to clearcutting of Pennsylvania hardwood forests. *Proceedings Pennsylvania Academy of Science*. 52(1): 21-23; 1978.
- Kirkland, G. L., Jr.; Schloyer, C. R.; Hull, D. K. A novel habitat record for the long-tailed shrew, *Sorex dispar* Batchelder. *Proceedings West Virginia Academy of Science*. 48(2, 3, 4): 77-79; 1976.
- Kirkland, G. L., Jr.; Knipe, C. M. The rock vole (*Microtus chrotorrhinus*) as a transition zone species. *Canadian Field-Naturalist*. 93(3): 319-321; 1979.
- Kirkland, G. L., Jr.; Van Deusen, H. M. The shrews of the *Sorex dispar* group: *Sorex dispar* Batchelder and *Sorex gaspensis* Anthony and Goodwin. *American Museum Novitates*. No. 2675: 1-21; 1979.
- Klein, H. G. Ecological relationships of *Peromyscus leucopus noveboracensis* and *P. maniculatus gracilis* in central New York. *Ecological Monographs*. 30: 387-407; 1960.
- Klugh, A. B. Ecology of the red squirrel. *Journal of Mammalogy*. 8(1): 1-32; 1927.
- Kunz, T. H. Reproduction of some vespertilionid bats in central Iowa. *American Midland Naturalist*. 86: 477-486; 1971.
- Kunz, T. H. Resource utilization: temporal and spatial components of bat activity in central Iowa. *Journal of Mammalogy*. 54(1): 14-32; 1973.
- Larson, J. S. Notes on a recent squirrel emigration in New England. *Journal of Mammalogy*. 43(2): 272-273; 1962.
- Larson, J. S. Age structure and sexual maturity with western Maryland beaver (*Castor canadensis*) population. *Journal of Mammalogy*. 48(3): 408-419; 1967.
- Lay, D. W. Ecology of the opossum in eastern Texas. *Journal of Mammalogy*. 23(2): 147-159; 1942.
- Layne, J. N. The biology of the red squirrel, *Tamiasciurus hudsonicus loquax* Bangs, in central New York. *Ecological Monographs*. 24: 227-267; 1954.
- Layne, J. N. Notes on mammals in southern Illinois. *American Midland Naturalist*. 60(1): 219-254; 1958.
- Layne, J. N.; Hamilton, W. J., Jr. The young of the woodland jumping mouse, *Napaeozapus insignis* Insignis Miller. *American Midland Naturalist*. 52(1): 224-247; 1954.
- Leftwich, B. H. Population dynamics and behavior of eastern mole, *Scalopus aquaticus machrinoides* Columbia, MO: University of Missouri, *Dissertation Abstracts*. 34B(3): 1324-5. 103 p.
- LeResche, R. E. Moose migrations in North America. *Canadian Field-Naturalist*. 101: 393-415; 1974.
- Lidicker, W. Z. Ecological observations on a feral house mouse population declining to extinction. *Ecological Monographs*. 36: 27-50; 1966.
- Liers, E. E. Notes on the river otter (*Lutra canadensis*). *Journal of Mammalogy*. 32(1): 1-9; 1951.
- Linscombe, G.; Kinler, N.; Aulerich, R. J. Mink. In: Chapman, J. A.; Feldhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 629-643.
- Llewellyn, L. M.; Dale, F. H. Notes on the ecology of the opossum in Maryland. *Journal of Mammalogy*. 45(1): 113-122; 1964.
- Long, C. A. Notes on habitat preference and reproduction in pygmy shrews (*Microsorex*). *Canadian Field-Naturalist*. 86(2): 155-160; 1972.
- Long, C. A. *Microsorex hoyi* and *Microsorex thomsoni*. *Mammalian Species*. Shippensburg, PA: American Society of Mammalogists; 1974; 33: 3-4.
- Lotze, J. H.; Anderson, S. *Procyon lotor*. *Mammalian Species*. Shippensburg, PA: American Society of Mammalogists; 1979; 119: 1-8.
- Lovejoy, D. A. Ecology of the woodland jumping mouse (*Napaeozapus insignis*) in New Hampshire. *Canadian Field-Naturalist*. 87(2): 145-149; 1973.
- Lovejoy, D. A. The effect of logging on small mammal populations in New England northern hardwood forests. University of Connecticut Occasional Papers. Biological Science Series. 2(17): 269-291; 1975.
- Lund, R. C. Return of the tiny tiger. *New Jersey Outdoors*. September/October: 17-19; 1980.
- Lynch, G. M. Long-range movement of a raccoon in Manitoba. *Journal of Mammalogy*. 48(4): 659-661; 1967.
- MacArthur, R. A. Winter movements and home range of the muskrat. *Canadian Field-Naturalist*. 92: 343-349; 1978.

- Clure, H. E. Summer activities of bats (*genus Lasius*) in Iowa. *Journal of Mammalogy*. 23(4): 430-434; 1942.
- Cord, C. M. Selection of winter habitat by bobcats (*Lynx rufus*) on the Quabbin Reservation, Massachusetts. *Journal of Mammalogy*. 55(2): 428-437; 1974.
- Cord, C. M. The bobcat in Massachusetts. *Massachusetts Wildlife*. 28(5): 2-8; 1977.
- Cord, C. M.; Cordoza, J. E. Bobcat and Lynx. In: Chapman, J. A.; Feldhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 728-766.
- Donough, J. J. The cottontail in Massachusetts. Boston, MA: Massachusetts Division of Fisheries and Game; 1960.
- Keever, S. The survey of West Virginia mammals. Charleston, WV: Conservation Commission West Virginia; 1952; Pittman-Robertson Project 22-TC. 126 p. mimeo.
- Manus, J. L. Activity of captive *Didelphis marsupialis*. *Journal of Mammalogy*. 52(4): 846-848; 1971.
- Manus, J. L. *Didelphis virginiana*. *Mammalian Species*. Shippensburg, PA: American Society of Mammalogists; 1974; 40: 1-6.
- Radford, J. R. Female territoriality in a Suffolk County, Long Island population of *Glaucomys volans*. *Journal of Mammalogy*. 55: 647-652; 1974.
- Rodgers, J. T.; Steventon, J. D.; Wynne, K. M. Comparison of marten home ranges calculated from recaptures and radio locations. *Transactions Northeast Section Wildlife Society*. 38: 109; 1981.
- Sanville, R. H. A study of small mammal populations in northern Michigan. University of Michigan, Miscellaneous Publications of the Museum of Zoology. 73: 1-83; 1949.
- Marshall, W. H. Pine marten as a forest product. *Journal of Forestry*. 49(12): 899-905; 1951.
- Marshall, W. H.; Gullion, G. W.; Schwab, R. G. Early summer activities of porcupines as determined by radio-positioning techniques. *Journal of Wildlife Management*. 26: 75-79; 1962.
- Martin, R. L. The natural history and taxonomy of the rock vole, *Microtus chrotorrhinus*. Dissertation Abstracts 32B: 3079. Storrs, CT: University of Connecticut; 1971. 164 p. Ph.D. dissertation.
- May, D. W. Habitat utilization by bobcats in Eastern Maine. *Transactions Northeast Section Wildlife Society*. 39: 22; 1982.
- Milne, W. E.; Hornocker, M. G. Methods and techniques for studying and censusing river otter populations. For. Wildl. and Range Exp. Stn., Tech. Rep. 8. Moscow, ID: University of Idaho; 1979. 17 p.
- Miller, D. H.; Getz, L. L. Life history notes on *Microtus pinetorum* in central Connecticut. *Journal of Mammalogy*. 50(4): 777-784; 1969.
- Miller, D. H.; Getz, L. L. Factors influencing the local distribution of the redback vole, *Clethrionomys gapperi*, in New England. University of Connecticut Occasional Papers. Biological Science Series. 2(9): 115-138; 1972.
- Miller, D. H.; Getz, L. L. Factors influencing the local distribution of the redback vole, *Clethrionomys gapperi*, in New England, II. Vegetation cover, soil moisture and debris cover. University of Connecticut Occasional Papers. Biological Science Series. 2(11): 159-180; 1973.
- Mills, R. S.; Barrett, G. W.; Farrell, M. P. Population dynamics of the big brown bat (*Eptesicus fuscus*) in southwestern Ohio. *Journal of Mammalogy*. 56(3): 591-604; 1975.
- Mitchell, J. L. Mink movements and populations on a Montana river. *Journal of Wildlife Management*. 25: 49-54; 1961.
- Mock, O. B. Reproduction of the least shrew (*Cryptotis parva*) in captivity. Columbia, MO: University of Missouri; 1970. Ph.D. dissertation.
- Mohr, C. E. Notes on the least bats (*Myotis subulatus leibii*). *Proceedings Pennsylvania Academy of Science*. 10: 62-65; 1936.
- Murie, A. The moose of Isle Royale. University of Michigan, Miscellaneous Publications of the Museum of Zoology. 25: 7-44; 1934.
- Muul, I. Behavioral and physiological influences on the distribution of the flying squirrel, *Glaucomys volans*. University of Michigan, Miscellaneous Publications of the Museum of Zoology. 134: 1-66; 1968.
- O'Donoghue, M. Seasonal habitat selection by snowshoe hare in Eastern Maine. *Transactions Northeast Section Wildlife Society*. 40: 100-107; 1983.
- Orr, R. T. Unusual behavior and occurrence of a hoary bat. *Journal of Mammalogy*. 31(4): 456-457; 1950.
- Ozoga, J. J.; Harger, E. M. Winter activities and feeding habits of northern Michigan coyotes. *Journal of Wildlife Management*. 30: 809-818; 1966.
- Pack, J.; Mosby, H.; Siegal, P. Influence of social hierarchy on gray squirrel behavior. *Journal of Wildlife Management*. 31: 720-728; 1967.
- Paradiso, J. L. Mammals of Maryland. North American Fauna Series No. 66: 1-193; 1969.
- Parker, G. R. The ecology of the lynx on Cape Breton Island. *Transactions Northeast Section Wildlife Society*. 39: 23; 1982.
- Pelton, M. R. Black Bear. In: Chapman, J. A.; Feldhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 504-514.
- Perry, H. R. Muskrats. In: Chapman, J. A.; Feldhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 282-325.
- Peterson, R. L. North American moose. Toronto, ON: University of Toronto Press; 1955. 280 p.

- Peterson, R. L. The mammals of eastern Canada. Toronto, ON: Oxford University Press; 1966. 465 p.
- Phillips, G. L. Ecology of the big brown bat (Chiroptera: Vespertilionidae) in northeastern Kansas. *American Midland Naturalist*. 75(1): 168-198; 1966.
- Phillips, R. L.; Andrews, R. D.; Storm, G. L.; Bishop, R. A. Dispersal and mortality of red foxes. *Journal of Wildlife Management*. 36: 237-248; 1972.
- Pollack, E. M. Observations on New England bobcats. *Journal of Mammalogy*, 32(3): 356-358; 1951.
- Preble, N. A. Notes on the life history of *Napaeozapus*. *Journal of Mammalogy*. 37(2): 197-200; 1956.
- Prince, L. A. Water traps capture the pygmy shrew (*Microsorex hoyi*) in abundance. *Canadian Field-Naturalist*. 55(5): 72; 1941.
- Pringle, L. P. A study of the biology and ecology of the New England cottontail (*Sylvilagus transitionalis*) in Massachusetts. Amherst, MA: University of Massachusetts; 1960. M.S. thesis.
- Pruitt, W. O., Jr. Microclimates and local distribution of small mammals on the George Reserve, Michigan. University of Michigan, Miscellaneous Publications of the Museum of Zoology. 109: 1-27; 1959.
- Quadagno, D. M. Home range size in feral house mice. *Journal of Mammalogy*. 49(1): 149-151; 1968.
- Quay, W. B. Notes on some bats from Nebraska and Wyoming. *Journal of Mammalogy*. 29(2): 181-182; 1948.
- Quick, H. F. Habits and economics of the New York weasel in Michigan. *Journal of Wildlife Management*. 8: 71-78; 1944.
- Quimby, D. C. The life history and ecology of the jumping mouse, *Zapus hudsonicus*. *Ecological Monographs*. 21: 61-95; 1951.
- Richmond, N. D.; Grimm, W. C. Ecology and distribution of the shrew, *Sorex dispar*, in Pennsylvania. *Ecology*. 31: 279-282; 1950.
- Rollings, C. T. Habits, foods and parasites of the bobcat in Minnesota. *Journal of Wildlife Management*. 9: 131-145; 1945.
- Ross, A. Ecological aspects of the food habits of insectivorous bats. *Proc. West. Found. Vertebr. Zool.* 1(4): 205-263; 1967.
- Sargeant, A. B. Red fox spatial characteristics in relation to waterfowl predation. *Journal of Wildlife Management*. 36: 225-236; 1972.
- Saunders, J., Jr. Food habits of the lynx in Newfoundland. *Journal of Wildlife Management*. 27: 384-390; 1963a.
- Saunders, J., Jr. Movements and activities of the lynx in Newfoundland. *Journal of Wildlife Management*. 27: 399-400; 1963b.
- Schwartz, C. W.; Schwartz, E. R. The wild mammals of Missouri. Columbia, MO: University of Missouri Press; 1959. 341 p.
- Scott, T. G. Some food coactions of the northern plains red fox. *Ecological Monographs*. 13: 427-479; 1943.
- Seagears, C. The fox in New York. Albany, NY: New York State Conservation Department; 1944. 85 p.
- Seton, E. T. The hoary bat or great northern bat. In: *Lives of game animals*. Vol. 2. New York: Scribner's Sons; 1909: 1191-1200.
- Seton, E. T. *Lives of game animals*. Garden City, NY: Doubleday, Doran and Co., Inc.; 1929. 4 vols.
- Shadle, A. R. Laboratory copulations and gestations of the porcupine, *Erethizon dorsatum*. *Journal of Mammalogy*. 32: 219-221; 1951.
- Shanks, C. E.; Arthur, G. C. Muskrat movements and population dynamics in Missouri ponds and streams. *Journal of Wildlife Management*. 16: 138-148; 1952.
- Shapiro, J. Ecological and life history notes on the porcupine in the Adirondacks. *Journal of Mammalogy*. 39(3): 247-257; 1949.
- Sharp, W. M. A commentary on the behavior of free-ranging gray squirrels. Pennsylvania Cooperative Wildlife Research Unit Paper 101: 1-13; 1960. Mimeo.
- Sheldon, C. Studies on the life histories of *Zapus* and *Napaeozapus* in Nova Scotia. *Journal of Mammalogy*. 15(4): 290-300; 1934.
- Sheldon, C. Vermont jumping mice of the genus *Napaeozapus*. *Journal of Mammalogy*. 19: 444-450; 1938.
- Short, H. L. Fall breeding activity of a young shrew. *Journal of Mammalogy*. 42(1): 95; 1961.
- Siegler, H. R. The status of wildcats in New Hampshire. In: *Symposium on the native cats of North America*. 36th North American Wildlife and Natural Resources Conference; Portland, OR. Washington, D.C.: Wildlife Management Institute; 1971: 46-52.
- Slate, D.; Wolgast, L. J.; Lund, R. C. Density and structure of New Jersey raccoon populations. *Transactions Northeast Section Wildlife Society*. 39: 19-20; 1982.
- Smith, N. B.; Barkalow, S. F., Jr. Precocious breeding of the gray squirrel. *Journal of Mammalogy*. 48(2): 323-330; 1967.
- Snyder, D. P. Survival rates, longevity and population fluctuations in the white-footed mouse, *Peromyscus leucopus*, in southern Michigan. University of Michigan, Miscellaneous Publications of the Museum of Zoology. 95: 1-33; 1956.
- Snyder, R. L.; Christian, J. J. Reproductive cycle and litter size of the woodchuck. *Ecology*. 41: 647-650; 1960.
- Sollberger, D. E. Notes on the life history of the small eastern flying squirrel. *Journal of Mammalogy*. 21(3): 282-293; 1940.
- Sollberger, D. E. Notes on the breeding habits of the eastern flying squirrel (*Glaucomys volans volans*). *Journal of Mammalogy*. 24(2): 163-173; 1943.
- Soutiere, E. C. The effects of timber harvesting on the fisher marten. Orono, ME: University of Maine; 1978. 62 p. M.S. thesis.
- Spencer, A. W.; Pettus, D. Habitat preferences of five sympatric species of long-tailed shrews. *Ecology*. 47: 677-683; 1966.

- encer, H. E., Jr. The black bear and its status in Maine. Augusta, Maine. Department of Inland Fisheries and Game, Bulletin No. 4: 1-55; 1961.
- ebler, A. M. The ecology of Michigan coyotes and wolves. Ann Arbor, MI: University of Michigan; 1951. 198 p. Ph.D. dissertation.
- orm, G. L. Movements and activities of foxes as determined by radio tracking. *Journal of Wildlife Management*. 29: 1-13; 1965.
- rickland, M. A.; Douglas, C. M.; Novak, M.; Hunzinger, N. P. Fisher. In: Chapman, J. A.; Feldhamer, G. A., eds. *Wild mammals of North America: Biology, management, and economics*. Baltimore, MD: Johns Hopkins University Press; 1982: 586-598.
- uewer, F. W. Raccoons: Their habits and management in Michigan. *Ecological Monographs*. 13: 203-257; 1942.
- ullivan, E. G. Gray fox reproduction, denning, range and weights in Alabama. *Journal of Mammalogy*. 37: 346-351; 1956.
- hla, A. Breeding habits and young of the red-backed mouse, *Evotomys*. *Papers Michigan Academy of Science Arts and Letters*. 11: 485-490; 1930.
- hla, A. A comparative life history study of the mice of the genus *Peromyscus*. University of Michigan, Miscellaneous Publications of the Museum of Zoology. 24: 1-39; 1932.
- ube, C. M. Food habitats of Michigan opossums. *Journal of Wildlife Management*. 11: 97-103; 1947.
- ylor, W. P. The deer of North America. The white-tailed, mule and black-tailed deer, genus *Odocoileus*, their history and management. Harrisburg, PA: Stackpole Company; Washington, DC; 1956. 668 p.
- nm, R. M.; Heaney, L. R.; Baird, D. D. Natural history of rock voles (*Microtus chrotorrhinus*) in Minnesota. *Canadian Field-Naturalist*. 91(2): 177-181; 1977.
- lig, H. G. The gray squirrel: Its life history, ecology and population characteristics in West Virginia. Pittman-Robertson Project 31-R. Charleston, WV: West Virginia Conservation Commission; 1955.
- urts, B. J. The biology of the striped skunk. Urbana, IL: University of Illinois Press; 1967. 218 p.
- alker, E. P.; Warnick, F.; Lange, K. I.; Vible, H. E.; Hamlet, S. E.; Davis, M. A.; Wright, P. F. *Mammals of the world*. 2 vols. Baltimore, MD: Johns Hopkins University Press; 1975. 1500 p.
- Whitaker, J. O., Jr. A study of the meadow jumping mouse, *Zapus hudsonicus* Zimmerman, in central New York. *Ecological Monographs*. 33: 215-254; 1963a.
- Whitaker, J. O., Jr. Food, habitat and parasites of the woodland jumping mouse in central New York. *Journal of Mammalogy*. 44(3): 316-321; 1963b.
- Whitaker, J. O., Jr. Hoary bat apparently hibernating in Indiana. *Journal of Mammalogy*. 48(4): 663; 1967.
- Whitaker, J. O., Jr. Food habits of bats from Indiana. *Canadian Journal of Zoology*. 50(6): 877-883; 1972a.
- Whitaker, J. O., Jr. *Zapus hudsonius*. *Mammalian Species*. Shippensburg, PA: American Society of Mammalogists; 1972b; 11: 1-7.
- Whitaker, J. O., Jr.; Mumford, R. E. Notes on occurrence and reproduction of bats in Indiana. *Proceedings Indiana Academy of Science*. 81: 376-383; 1972.
- Whitaker, J. O., Jr.; Wrigley, R. E. *Napaeozapus insignis*. *Mammalian Species*. Shippensburg, PA: American Society of Mammalogists; 1972; 14: 1-6.
- Whitney, L. F.; Underwood, A. B. The raccoon. Orange, CT: Practical Science Publishing Company; 1952.
- Wimsatt, W. A. Notes on breeding behavior, pregnancy and parturition in some Vespertilionid bats of the eastern United States. *Journal of Mammalogy*. 26: 23-33; 1945.
- Wiseman, G. L.; Hendrickson, G. O. Notes on the life history and ecology of the opossum in southeast Iowa. *Journal of Mammalogy*. 31(3): 331-337; 1950.
- Wood, J. E. Age structure and productivity of a gray fox population. *Journal of Mammalogy*. 39: 74-86; 1958.
- Wright, B. A. The cougar is alive and well in Massachusetts. *Massachusetts Wildlife*. 24(3): 2-8, 19; 1973.
- Wright, P. L. Delayed implantation in the long-tailed weasel (*Mustela frenata*), the short-tailed weasel (*Mustela cicognani*), and the marten (*Martes americana*). *Anatomical Record*. 83(3): 341-353; 1942.
- Wright, P. L. Breeding habits of captive long-tailed weasels (*Mustela frenata*). *American Midland Naturalist*. 39(2): 338-344; 1948.
- Wright, P. L.; Coulter, M. W. Reproduction and growth in Maine fishers. *Journal of Wildlife Management*. 31: 70-86; 1967.
- Wrigley, R. E. Systematics and biology of the woodland jumping mouse, *Napaeozapus insignis*. *Illinois Biol. Monogr.* 47. Urbana, IL: University of Chicago Press; 1972. 117 p.
- Wrigley, R. E.; Dubois, J. E.; Copeland, H. W. R. Habitat, abundance and distribution of six species of shrews in Manitoba. *Journal of Mammalogy*. 60(3): 505-520; 1979.
- Yahner, R. H. The adaptive nature of the social system and behavior in the eastern chipmunk, *Tamias striatus*. *Behavior Ecology and Sociobiology*. 3: 397-427; 1978.
- Yates, T. L.; Schmidly, D. J. *Scalopus aquaticus*. *Mammalian Species*. Shippensburg, PA: American Society of Mammalogists; 1978; 105: 1-4.
- Yearsley, E. F.; Samuel, D. E. Use of reclaimed surface mines by foxes in West Virginia. *Journal of Wildlife Management*. 44: 729-734; 1980.
- Yerger, R. W. Home range, territoriality and populations of the chipmunk in central New York. *Journal of Mammalogy*. 34(4): 448-458; 1953.
- Yerger, R. W. Life history notes on the eastern chipmunk, *Tamias striatus lysteri* Richardson, in central New York. *American Midland Naturalist*. 53: 312-323; 1955.
- Young, S. P.; Goldman, E. A. The puma, mysterious American cat. Washington, DC: American Wildlife Institute; 1946. 358 p.



Special Status Designations

Many wildlife species or subspecies in New England are protected by state or federal legislation, by hunting regulations, or have been noted by private conservation groups as species deserving special consideration due to their relative scarcity. Because of the variety of regulations and legislation that exists for different species within the six-state region, we have not attempted to define or list any of these special status categories. Instead, we have listed all the species or subspecies that have a special status designation, and we have indicated the applicable state (not necessarily included in state

regulations). These categories have been determined by either a private group or a state agency and include such designations as state endangered, threatened, or rare.

If interested in further information regarding species' status in a particular state, the user should contact the state agency with jurisdiction over wildlife, the Natural Heritage Program of The Nature Conservancy in that state, or the Audubon Society chapter, and so on. Species that are covered by state hunting laws are not included in this list.

AMPHIBIANS

	ME	NH	VT	MA	RI	CT
Mudpuppy, <i>Necturus m. maculosus</i>			*	*	*	*
Marbled Salamander, <i>Ambystoma opacum</i>		*		*	*	*
Jefferson Salamander, <i>Ambystoma jeffersonianum</i>		*	*	*		*
Blue-spotted Salamander, <i>Ambystoma laterale</i>	*	*	*	*		*
Silvery Salamander, <i>Ambystoma platineum</i>			*			
Tremblay's Salamander, <i>Ambystoma tremblayi</i>	*		*			
Slimy Salamander, <i>Plethodon g. glutinosus</i>		*		*		*
Northern Spring Salamander, <i>Gyrinophilus p. porphyriticus</i>	*	*	*	*		*
Eastern Spadefoot, <i>Scaphiopus h. holbrookii</i>				*	*	*
Fowler's Toad, <i>Bufo woodhousii fowleri</i>	*	*				
Mink Frog, <i>Rana septentrionalis</i>	*	*	*			

REPTILES

	ME	NH	VT	MA	RI	CT
Stinkpot, <i>Sternotherus odoratus</i>			*			
Spotted Turtle, <i>Clemmys guttata</i>	*	*	*	*	*	*
Bog Turtle, <i>Clemmys muhlenbergii</i>			*	*		*
Wood Turtle, <i>Clemmys insculpta</i>	*	*	*	*	*	*
Eastern Box Turtle, <i>Terrapene c. carolina</i>	*	*		*	*	*
Map Turtle, <i>Graptemys geographica</i>			*			
Plymouth Redbelly Turtle, <i>Pseudemys rubriventris bangsi</i>				*		
Blanding's Turtle, <i>Emydoidea blandingii</i>	*	*		*		*
Eastern Spiny Softshell, <i>Trionyx s. spiniferus</i>			*			
Five-lined Skink, <i>Eumeces fasciatus</i>			*	*		*
Eastern Hognose Snake, <i>Heterodon platyrhinos</i>		*			*	*
Eastern Worm Snake, <i>Carphophis a. amoenus</i>	*			*	*	*
Eastern Smooth Green Snake, <i>Opheodrys v. vernalis</i>					*	
Black Rat Snake, <i>Elaphe o. obsoleta</i>		*	*	*	*	*
Northern Copperhead, <i>Agkistrodon contortrix mokeson</i>				*	*	
Timber Rattlesnake, <i>Crotalus horridus</i>		*	*	*	*	*

BIRDS

	ME	NH	VT	MA	RI	CT
Common Loon, <i>Gavia immer</i>	*	*	*	*		*
Pied-billed Grebe, <i>Podilymbus podiceps</i>	*	*	*	*	*	*
American Bittern, <i>Botaurus lentiginosus</i>	*	*	*	*	*	*
Least Bittern, <i>Ixobrychus exilis</i>	*	*	*	*	*	*
Black-crowned Night-heron, <i>Nycticorax nycticorax</i>	*		*	*	*	*
Yellow-crowned Night-heron, <i>Nycticorax violaceus</i>						*
Glossy Ibis, <i>Plegadis falcinellus</i>	*	*		*	*	*
Hooded Merganser, <i>Lophodytes cucullatus</i>						*
Common Merganser, <i>Mergus merganser</i>						*
Red-breasted Merganser, <i>Mergus serrator</i>			*			
Osprey, <i>Pandion haliaetus</i>	*	*	*	*	*	*
Bald Eagle, <i>Haliaeetus leucocephalus</i>	*	*	*	*		
Northern Harrier, <i>Circus cyaneus</i>	*	*	*	*		
Sharp-shinned Hawk, <i>Accipiter striatus</i>				*	*	*
Cooper's Hawk, <i>Accipiter cooperii</i>	*	*	*	*	*	*

BIRDS

ME NH VT MA RI C

Northern Goshawk, <i>Accipiter gentilis</i>					*
Red-shouldered Hawk, <i>Buteo lineatus</i>	*	*	*	*	*
Golden Eagle, <i>Aquila chrysaetos</i>	*				
Merlin, <i>Falco columbarius</i>	*	*			
Peregrine Falcon, <i>Falco peregrinus</i>	*	*	*	*	
Spruce Grouse, <i>Dendragapus canadensis</i>			*		
King Rail, <i>Rallus elegans</i>		*	*	*	*
Sora, <i>Porzana carolina</i>		*	*	*	*
Common Moorhen, <i>Gallinula chloropus</i>	*	*	*	*	*
American Coot, <i>Fulica americana</i>			*	*	*
Piping Plover, <i>Charadrius melodus</i>	*			*	*
Upland Sandpiper, <i>Bartramia longicauda</i>	*	*	*	*	*
Black Tern, <i>Chlidonias niger</i>	*	*	*	*	*
Common Barn-Owl, <i>Tyto alba</i>	*	*	*	*	*
Long-eared Owl, <i>Asio otus</i>		*	*	*	*
Short-eared Owl, <i>Asio flammeus</i>	*	*	*	*	*
Whip-poor-will, <i>Caprimulgus vociferus</i>		*			
Red-headed Woodpecker, <i>Melanerpes erythrocephalus</i>	*	*	*	*	*
Three-toed Woodpecker, <i>Picoides tridactylus</i>	*	*	*		
Black-backed Woodpecker, <i>Picoides arcticus</i>		*	*		
Olive-sided Flycatcher, <i>Contopus borealis</i>				*	*
Acadian Flycatcher, <i>Empidonax virescens</i>				*	*
Horned Lark, <i>Eremophila alpestris</i>					*
Cliff Swallow, <i>Hirundo pyrrhonota</i>					*
Purple Martin, <i>Progne subis</i>		*		*	
Gray Jay, <i>Perisoreus canadensis</i>		*	*		
Carolina Wren, <i>Thryothorus ludovicianus</i>			*		
Winter Wren, <i>Troglodytes troglodytes</i>					*
Sedge Wren, <i>Cistothorus platensis</i>	*	*	*	*	*
Golden-crowned Kinglet, <i>Regulus satrapa</i>		*			
Eastern Bluebird, <i>Sialia sialis</i>				*	
Gray-cheeked Thrush, <i>Catharus minimus</i>	*	*	*	*	
Loggerhead Shrike, <i>Lanius ludovicianus</i>	*	*	*	*	
Golden-winged Warbler, <i>Vermivora chrysoptera</i>			*	*	
Northern Parula, <i>Parula americana</i>				*	*
Magnolia Warbler, <i>Dendroica magnolia</i>					*
Yellow-rumped Warbler, <i>Dendroica coronata</i>					*
Pine Warbler, <i>Dendroica pinus</i>		*			
Cerulean Warbler, <i>Dendroica cerulea</i>			*		
Kentucky Warbler, <i>Oporornis formosus</i>				*	
Wilson's Warbler, <i>Wilsonia pusilla</i>			*		*
Yellow-breasted Chat, <i>Icteria virens</i>			*		*
Vesper Sparrow, <i>Pooecetes gramineus</i>				*	*
Savannah Sparrow, <i>Passerculus sandwichensis</i>	*	*	*	*	*
Grasshopper Sparrow, <i>Ammodramus savannarum</i>		*	*	*	
Henslow's Sparrow, <i>Ammodramus henslowii</i>				*	
White-throated Sparrow, <i>Zonotrichia albicollis</i>	*	*			
Orchard Oriole, <i>Icterus spurius</i>	*				
Pine Grosbeak, <i>Pinicola enucleator</i>					*
Evening Grosbeak, <i>Coccothraustes vespertinus</i>					*

MAMMALS

ME NH VT MA RI CT

Water Shrew, <i>Sorex palustris</i>				*	*	*
Smoky Shrew, <i>Sorex fumeus</i>					*	
Long-tailed or Rock Shrew, <i>Sorex dispar</i>	*	*	*	*		
Least Shrew, <i>Cryptotis parva</i>						*
Indiana Myotis, <i>Myotis sodalis</i>		*	*	*		*
Small-footed Myotis, <i>Myotis leibii</i>	*		*	*		*
New England Cottontail, <i>Sylvilagus transitionalis</i>		*			*	
Northern Flying Squirrel, <i>Glaucomys sabrinus</i>						*
Deer Mouse, <i>Peromyscus maniculatus</i>						*
Rock Vole, <i>Microtus chrotorrhinus</i>	*	*	*			
Southern Bog Lemming, <i>Synaptomys cooperi</i>		*		*	*	*
Northern Bog Lemming, <i>Synaptomys borealis</i>	*	*				
Woodland Jumping Mouse, <i>Napaeozapus insignis</i>					*	
Porcupine, <i>Erethizon dorsatum</i>		*	*			
Black Bear, <i>Ursus americanus</i>						*
Marten, <i>Martes americana</i>		*	*			*
Fisher, <i>Martes pennanti</i>						*
Eastern Cougar, <i>Felis concolor cougar</i>						
Lynx, <i>Felis lynx</i>	*	*	*			
Bobcat, <i>Felis rufus</i>					*	

Coastal and Migrant Species

Species	Season	Habitat
Coastal		
Northern Diamondback Terrapin <i>Malaclemys t. terrapin</i>	permanent resident	coastal marshes
Red-throated Loon <i>Gavia stellata</i>	winter	coastal bays
Horned Grebe <i>Podiceps auritus</i>	winter	coastal bays
Red-necked Grebe <i>Podiceps grisegena</i>	winter	coastal bays
Leach's Storm-Petrel <i>Oceanodroma leucorhoa</i>	breeding	coastal rocks
Great Cormorant <i>Phalacrocorax carbo</i>	permanent resident	coastal rocks
Double-crested Cormorant <i>Phalacrocorax auritus</i>	breeding	coastal rocks
Great Egret <i>Casmerodius albus</i>	breeding	coastal marsh

Species	Season	Habitat
Snowy Egret <i>Egretta thula</i>	breeding	coastal marsh
Little Blue Heron <i>Egretta caerulea</i>	breeding	coastal marsh— persistent emergent vegetation
Tricolored Heron <i>Egretta tricolor</i>	breeding	coastal marsh
Cattle Egret* <i>Bubulcus ibis</i>	breeding	coastal marsh
Snow Goose <i>Chen caerulescens</i>	winter	coastal bays, estuaries
Brant <i>Branta bernicla</i>	winter	coastal bays
Redhead* <i>Aythya americana</i>	winter	coastal bays
Greater Scaup <i>Aythya marila</i>	winter	coastal bays, estuaries
Lesser Scaup <i>Aythya affinis</i>	winter	coastal bays, estuaries
Common Eider <i>Somateria mollissima</i>	breeding and winter	coastal bays, ocean
King Eider <i>Somateria spectabilis</i>	winter	coastal bays, ocean
Harlequin Duck <i>Histrionicus histrionicus</i>	winter	coastal bays
Oldsquaw <i>Clangula hyemalis</i>	winter	coastal bays, ocean
Black Scoter <i>Melanitta nigra</i>	winter	coastal bays, ocean
Surf Scoter <i>Melanitta perspicillata</i>	winter	coastal bays, ocean
White-winged Scoter <i>Melanitta fusca</i>	winter	coastal bays, ocean
Barrow's Goldeneye <i>Bucephala islandica</i>	winter	coastal bays, ocean
Ruddy Duck <i>Oxyura jamaicensis</i>	breeding (rare)	coastal marshes, bays
		winter

*Found inland on rare occasions.

Species	Season	Habitat
Clapper Rail <i>Rallus longirostris</i>	permanent resident	coastal marsh
Black-bellied Plover <i>Pluvialis squatarola</i>	winter	coastal mud flat
Piping Plover <i>Charadrius melodus</i>	breeding	coastal beach
American Oystercatcher <i>Haematopus palliatus</i>	breeding	coastal beach, rocks
Willet <i>Catoptrophorus semipalmatus</i>	breeding	coastal beach
Whimbrel <i>Numenius phaeopus</i>	migrant	coastal mud flat
Hudsonian Godwit <i>Limosa haemastica</i>	migrant	coastal mud flat
Marbled Godwit <i>Limosa fedoa</i>	migrant	coastal mud flat
Ruddy Turnstone <i>Arenaria interpres</i>	winter	coastal mud flat
Red Knot <i>Calidris canutus</i>	winter	coastal mud flat
Semipalmated Sandpiper <i>Calidris pusilla</i>	migrant	coastal mud flat
White-rumped Sandpiper <i>Calidris fuscicollis</i>	migrant	coastal marsh, mud flat
Baird's Sandpiper <i>Calidris bairdii</i>	migrant	coastal marsh, mud flat
Sectoral Sandpiper <i>Calidris melanotos</i>	migrant	coastal marsh, mud flat
Purple Sandpiper <i>Calidris maritima</i>	winter	coastal rocks
Punlin <i>Calidris alpina</i>	winter	coastal beach
Stilt Sandpiper <i>Calidris himantopus</i>	migrant	coastal marsh, mud flat
Short-billed Dowitcher <i>Limnodromus griseus</i>	migrant	coastal marsh, mud flat
Red-necked Phalarope <i>Phalaropus lobatus</i>	migrant	coastal marsh, estuary, ocean

Species	Season	Habitat
Red Phalarope <i>Phalaropus fulicaria</i>	migrant	coastal marsh, estuary, ocean
Laughing gull <i>Larus atricilla</i>	breeding	coast
Bonaparte's Gull <i>Larus philadelphia</i>	winter	coast
Iceland Gull <i>Larus glaucoides</i>	winter	coast
Glaucous Gull <i>Larus hyperboreus</i>	winter	coast
Roseate Tern <i>Sterna dougallii</i>	breeding	coastal beach
Arctic Tern <i>Sterna paradisaea</i>	breeding	coastal beach
Least Tern <i>Sterna antillarum</i>	breeding	coastal beach
Black Skimmer <i>Rynchops niger</i>	breeding	coastal beach
Razorbill <i>Alca torda</i>	breeding and winter	coastal rocks
Black Guillemot <i>Cephus grylle</i>	breeding and winter	coastal rocks
Atlantic Puffin <i>Fratercula arctica</i>	breeding and winter	coastal rocks
Dickcissel <i>Spiza americana</i>	breeding, permanent resident	coastal marsh
Sharp-tailed Sparrow <i>Ammodramus caudacutus</i>	breeding, coastal marsh permanent resident	coastal marsh
Seaside Sparrow <i>Ammodramus maritimus</i>	permanent resident	coastal marsh
Migrant		
Greater Yellowlegs <i>Tringa melanoleuca</i>	migrant spring fall	fresh and coastal marshes coastal marsh
Lesser Yellowlegs <i>Tringa flavipes</i>	migrant spring fall	fresh and coastal marshes coastal marsh

Species	Season	Habitat
Solitary Sandpiper <i>Tringa solitaria</i>	migrant	fresh marsh
Sanderling <i>Calidris alba</i>	winter	ocean beach
Least Sandpiper <i>Calidris minutilla</i>	migrant	marshes, mud flats
Water Pipit <i>Anthus spinoletta</i>	migrant	plowed fields
Orange-crowned Warbler <i>Vermivora celata</i>	migrant	woodlands
White-crowned Sparrow <i>Zonotrichia leucophrys</i>	migrant	field edges
Black-tailed Jackrabbit <i>Lepus californicus</i>		Introduced on Nantucket Island, Massachusetts

Guild Designations for Inland Wildlife of New England

C — Carnivore
O — Omnivore
P — Piscivore
F — Frugivore
I — Insectivore
H — Herbivore
G — Granivore

Common Name	Summer Foraging	Breeding Substrate	Winter Foraging
Mudpuppy	C : Water Ambusher	Water	C : Water Ambusher
Marbled Salamander	I : Ground Gleaner	Water	
Jefferson Salamander	I : Ground Gleaner	Water	
Silvery Salamander	I : Ground Gleaner	Water	
Blue-spotted Salamander	I : Ground Gleaner	Water	
Tremblay's Salamander	I : Ground Gleaner	Water	
Spotted Salamander	I : Ground Gleaner	Water	
Red-spotted Newt	I : Water Gleaner	Water	I : Water Gleaner
Northern Dusky Salamander	I : Water Gleaner	Riparian Subsurface	I : Water Gleaner
Mountain Dusky Salamander	I : Ground Gleaner	Terrestrial Subsurface	
Redback Salamander	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Slimy Salamander	I : Ground Gleaner	Terrestrial Subsurface	
Four-toed Salamander	I : Ground Gleaner	Riparian Ground	
Northern Spring Salamander	I : Water Gleaner	Water	I : Water Gleaner
Northern Two-lined Salamander	I : Water Gleaner	Water	I : Water Gleaner
Eastern Spadefoot	I : Ground Ambusher	Water	
Eastern American Toad	I : Ground Ambusher	Water	
Fowler's Toad	I : Ground Ambusher	Water	
Northern Spring Peeper	I : Riparian Ambusher	Water	
Gray Treefrog	I : Bark Ambusher	Water	
Bullfrog	C : Water Ambusher	Water	
Green Frog	C : Riparian Ambusher	Water	
Mink Frog	I : Water Ambusher	Water	
Wood Frog	I : Ground Ambusher	Water	
Northern Leopard Frog	I : Riparian Ambusher	Water	
Pickerel Frog	I : Riparian Ambusher	Water	
Common Snapping Turtle	O : Bottom Forager	Riparian Subsurface	O : Bottom Forager
Stinkpot	C : Bottom Forager	Riparian Subsurface	
Spottled Turtle	O : Bottom Forager	Riparian Subsurface	
Bog Turtle	O : Riparian Forager	Riparian Ground	
Wood Turtle	O : Ground Forager	Terrestrial Subsurface	
Eastern Box Turtle	O : Ground Forager	Terrestrial Subsurface	
Map Turtle	O : Bottom Forager	Terrestrial Subsurface	
Red-eared Slider	O : Bottom Forager	Terrestrial Subsurface	
Plymouth Redbelly Turtle	H : Water Grazer	Riparian Subsurface	
Eastern Painted Turtle	O : Bottom Forager	Terrestrial Subsurface	
Midland Painted Turtle	O : Bottom Forager	Riparian Subsurface	O : Bottom Forager
Blanding's Turtle	O : Bottom Forager	Riparian Subsurface	
Eastern Spiny Softshell	I : Water Ambusher	Riparian Subsurface	
Five-lined Skink	I : Ground Ambusher	Terrestrial Subsurface	
Northern Water Snake	C : Water Ambusher	Riparian Subsurface	
Northern Brown Snake	I : Ground Ambusher	Terrestrial Subsurface	
Northern Redbelly Snake	I : Ground Ambusher	Terrestrial Subsurface	
Eastern Garter Snake	C : Ground Ambusher	Terrestrial Subsurface	
Maritime Garter Snake	I : Ground Ambusher	Terrestrial Subsurface	
Eastern Ribbon Snake	C : Ground Ambusher	Riparian Subsurface	
Northern Ribbon Snake	C : Water Ambusher	Riparian Subsurface	
Eastern Hognose Snake	C : Ground Ambusher	Terrestrial Subsurface	
Northern Ringneck Snake	C : Ground Ambusher	Terrestrial Subsurface	
Eastern Worm Snake	I : Ground Gleaner	Terrestrial Subsurface	
Northern Black Racer	C : Ground Ambusher	Terrestrial Subsurface	
Eastern Smooth Green Snake	I : Ground Ambusher	Terrestrial Subsurface	
Black Rat Snake	C : Ground Ambusher	Terrestrial Subsurface	
Eastern Milk Snake	C : Ground Ambusher	Terrestrial Subsurface	
Northern Copperhead	C : Ground Ambusher	Terrestrial Subsurface	

Common Name	Summer Foraging	Breeding Substrate	Winter Foraging
Timber Rattlesnake	C : Ground Ambusher	Terrestrial Subsurface	
Common Loon	P : Water Diver	Riparian Subsurface	P : Ocean Diver
Pied-billed Grebe	O : Bottom Forager	Water	O : Bottom Forager
American Bittern	C : Water Ambusher	Riparian Ground	
Least Bittern	C : Water Ambusher	Riparian Herb-Shrub	
Great Blue Heron	C : Water Ambusher	Riparian Twig-Branch	
Green-backed Heron	C : Water Ambusher	Riparian Shrub	
Black-crowned Night-Heron	C : Water Ambusher	Riparian Twig-Branch	C : Water Ambusher
Yellow-crowned Night-Heron	C : Water Ambusher	Riparian Twig-Branch	
Glossy Ibis	O : Riparian Prober	Riparian Ground	
Mute Swan	H : Water Grazer	Riparian Ground	H : Water Grazer
Canada Goose	H : Ground Grazer	Riparian Ground	H : Ground Grazer
Wood Duck	G : Water Forager	Riparian Tree Cavity	
Green-winged Teal	H : Water Grazer	Riparian Ground	H : Water Grazer
American Black Duck	O : Water Forager	Riparian Ground	O : Water Forager
Mallard	G : Water Forager	Riparian Ground	O : Water Forager
Norther Pintail	O : Water Forager		
Blue-winged Teal	O : Water Forager	Riparian Ground	
Northern Shoveler	O : Water Forager	Riparian Ground	O : Water Forager
Gadwall	H : Water Grazer	Riparian Ground	H : Water Grazer
American Widgeon	H : Water Grazer	Riparian Ground	H : Water Grazer
Canvasback			O : Ocean Bottom Forager
Ring-necked Duck	O : Bottom Forager	Riparian Ground	H : Bottom Forager
Common Goldeneye	O : Bottom Forager	Riparian Tree Cavity	O : Bottom Forager
Bufflehead	O : Bottom Forager	Riparian Tree Cavity	O : Bottom Forager
Hooded Merganser	P : Water Diver	Riparian Tree Cavity	P : Water Diver
Common Merganser	P : Water Diver	Riparian Tree Cavity	P : Water Diver
Red-breasted Merganser	P : Water Diver	Riparian Ground	P : Ocean Diver
Turkey Vulture	C : Ground Scavenger	Ground-Herb	C : Ground Scavenger
Osprey	P : Water Foot-Plunger	Tree Branch	
Bald Eagle	P : Water Foot-Plunger	Tree Branch	C : Ground Scavenger
Northern Harrier	C : Ground Pouncer	Riparian Ground	C : Ground Pouncer
Sharp-shinned Hawk	C : Air Hawker	Tree-Branch	C : Air Hawker
Cooper's Hawk	C : Air Hawker	Tree-Branch	C : Air Hawker
Northern Goshawk	C : Air Hawker	Tree-Branch	C : Air Hawker
Red-shouldered Hawk	C : Ground Pouncer	Tree-Branch	C : Ground Pouncer
Broad-winged Hawk	C : Ground Pouncer	Tree-Branch	
Red-tailed Hawk	C : Ground Pouncer	Tree-Branch	C : Ground Pouncer
Rough-legged Hawk			C : Ground Pouncer
Golden Eagle	C : Ground Pouncer	Cliff	C : Ground Pouncer
American Kestrel	C : Ground Pouncer	Tree-Branch	C : Ground Pouncer
Merlin	C : Air Hawker	Tree-Branch	C : Air Hawker
Peregrine Falcon	C : Air Hawker	Cliff	
Gray Partridge	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Ring-necked Pheasant	O : Ground Gleaner	Ground-Herb	O : Ground Gleaner
Spruce Grouse	O : Ground Gleaner	Ground-Herb	H : Upper Canopy Forager
Ruffed Grouse	O : Ground Gleaner	Ground-Herb	H : Upper Canopy Forager
Wild Turkey	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Bobwhite	O : Ground Gleaner	Ground Herb	O : Ground Gleaner
King Rail	I : Coastal Prober	Riparian Ground	O : Coastal Prober
Virginia Rail	O : Riparian Gleaner	Riparian Ground	O : Riparian Gleaner
Sora	O : Riparian Gleaner	Riparian Ground	
Common Moorhen	O : Riparian Gleaner	Riparian Ground	
American Coot	O : Bottom Forager	Riparian Ground	H : Bottom Forager
Killdeer	I : Ground Gleaner	Ground-Herb	I : Ground Gleaner
Spotted Sandpiper	O : Riparian Gleaner	Ground-Herb	

Common Name

Summer Foraging

Breeding Substrate

Winter Foraging

Upland Sandpiper	I : Ground Gleaner	Ground-Herb	
Common Snipe	I : Water Gleaner	Riparian Ground	I : Water Gleaner
American Woodcock	I : Ground Prober	Ground-Herb	
Ringed-billed Gull			
Herring Gull	C : Coastal Scavenger	Beach-Rock-Dune	C : Coastal Scavenger
Great Black-backed Gull	C : Coastal Scavenger	Beach-Rock-Dune	C : Coastal Scavenger
Common Tern	P : Water Plunger	Beach-Rock-Dune	
Black Tern	I : Water Gleaner	Ground-Herb	
Rock Dove	O : Ground Gleaner	Buildings	O : Ground Gleaner
Mourning Dove	G : Ground Gleaner	Tree-Branch	G : Ground Gleaner
Black-billed Cuckoo	I : Lower Canopy Gleaner	Tree-Branch	
Yellow-billed Cuckoo	I : Lower Canopy Gleaner	Tree-Branch	
Common Barn-Owl	C : Ground Pouncer	Buildings	C : Ground Pouncer
Eastern Screech-Owl	C : Ground Pouncer	Tree Cavity-Crevise	C : Ground Pouncer
Great Horned Owl	C : Ground Pouncer	Tree-Branch	C : Ground Pouncer
Snowy Owl			
Northern Hawk-Owl			
Barred Owl	C : Ground Pouncer		C : Ground Pouncer
Great Gray Owl			C : Ground Pouncer
Long-eared Owl	C : Ground Pouncer	Tree-Branch	C : Ground Pouncer
Short-eared Owl	C : Ground Pouncer	Beach-Rock-Dune	C : Ground Pouncer
Boreal Owl			C : Ground Pouncer
Northern Saw-whet Owl	C : Ground Pouncer	Tree Cavity-Crevise	C : Ground Pouncer
Common Nighthawk	I : Air Screener	Ground-Herb	
Whip-poor-will	I : Air Screener	Ground-Herb	
Chimney Swift	I : Air Screener	Buildings	
Ruby-throated Hummingbird	O : Floral Hover-Gleaner	Tree-Branch	
Belted Kingfisher	P : Water Plunger	Riparian Subsurface	P : Water Plunger
Red-headed Woodpecker	I : Bark Gleaner	Tree Cavity-Crevise	I : Bark Gleaner
Red-bellied Woodpecker	I : Bark Gleaner	Tree Cavity-Crevise	I : Bark Gleaner
Yellow-bellied Sapsucker	O : Bark Excavator	Tree Cavity-Crevise	I : Bark Gleaner
Downy Woodpecker	I : Bark Gleaner	Tree Cavity-Crevise	I : Bark Gleaner
Hairy Woodpecker	I : Bark Gleaner	Tree Cavity-Crevise	I : Bark Gleaner
Three-toed Woodpecker	I : Bark Scaler	Tree Cavity-Crevise	I : Bark Scaler
Black-backed Woodpecker	I : Bark Scaler	Tree Cavity-Crevise	I : Bark Scaler
Northern Flicker	I : Ground Gleaner	Tree Cavity-Crevise	O : Ground Gleaner
Pileated Woodpecker	I : Bark Excavator	Tree Cavity-Crevise	I : Bark Excavator
Olive-sided Flycatcher	I : Air Sallier	Tree Branch	
Eastern Wood Pewee	I : Air Sallier	Tree Branch	
Yellow-bellied Flycatcher	I : Air Sallier	Ground-Herb	
Acadian Flycatcher	I : Air Sallier	Tree-Twig	
Alder Flycatcher	I : Air Sallier	Shrub	
Willow Flycatcher	I : Air Sallier	Shrub	
Least Flycatcher	I : Air Sallier	Tree-Branch	
Eastern Phoebe	I : Air Sallier	Buildings	
Great Crested Flycatcher	I : Air Sallier	Tree Cavity-Crevise	
Eastern Kingbird	I : Air Sallier	Tree-Twig	
Horned Lark	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Purple Martin	I : Air Screener	Buildings	
Tree Swallow	I : Air Screener	Tree Cavity-Crevise	
Northern Rough-winged Swallow	I : Air Screener	Terrestrial Subsurface	
Bank Swallow	I : Air Screener	Terrestrial Subsurface	
Cliff Swallow	I : Air Screener	Buildings	
Barn Swallow	I : Air Screener	Buildings	
Gray Jay	O : Upper Canopy Gleaner	Tree-Branch	O : Upper Canopy Gleaner
Blue Jay	O : Ground Gleaner	Tree-Branch	O : Ground Gleaner
American Crow	O : Ground Gleaner	Tree-Branch	O : Ground Gleaner
Fish Crow	O : Ground Gleaner	Riparian Twig-Branch	O : Ground Gleaner

Common Name	Summer Foraging	Breeding Substrate	Winter Foraging
Common Raven	C : Ground Scavenger	Cliff	C : Ground Scavenger
Black-capped Chickadee	I : Lower Canopy Gleaner	Tree Cavity-Crevise	O : Lower Canopy Gleaner
Boreal Chickadee	I : Lower Canopy Gleaner	Tree Cavity-Crevise	I : Lower Canopy Gleaner
Tufted Titmouse	I : Lower Canopy Gleaner	Tree Cavity-Crevise	O : Lower Canopy Gleaner
Red-breasted Nuthatch	I : Bark Gleaner	Tree Cavity-Crevise	I : Bark Gleaner
White-breasted Nuthatch	I : Bark Gleaner	Tree-Cavity-Crevise	I : Bark Gleaner
Brown Creeper	I : Bark Gleaner	Tree Cavity-Crevise	I : Bark Gleaner
Carolina Wren	I : Lower Canopy Gleaner	Tree Cavity-Crevise	I : Lower Canopy Gleaner
House Wren	I : Lower Canopy Gleaner	Tree Cavity-Crevise	
Winter Wren	I : Ground Gleaner	Tree Cavity-Crevise	I : Ground Gleaner
Sedge Wren	I : Ground Gleaner	Riparian Ground	
Marsh Wren	I : Ground Gleaner	Riparian Ground	
Golden-crowned Kinglet	I : Lower Canopy Gleaner	Tree-Twig	I : Lower Canopy Gleaner
Ruby-crowned Kinglet	I : Lower Canopy Gleaner	Tree-Twig	I : Lower Canopy Gleaner
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Eastern Bluebird	O : Ground Gleaner	Tree Cavity-Crevise	O : Ground Gleaner
Veery	O : Ground Gleaner	Ground-Herb	
Gray-cheeked Thrush	I : Ground Gleaner	Tree-Branch	
Swainson's Thrush	I : Ground Gleaner	Tree-Twig	
Hermit Thrush	I : Ground Gleaner	Ground-Herb	O : Ground Gleaner
Wood Thrush	O : Ground Gleaner	Tree-Branch	
American Robin	O : Ground Gleaner	Tree-Branch	O : Ground Gleaner
Gray Catbird	O : Ground Gleaner	Shrub	
Northern Mockingbird	O : Ground Gleaner	Shrub	F : Lower Canopy Gleaner
Brown Thrasher	O Ground Gleaner	Shrub	O : Ground Gleaner
Bohemian Waxwing			
Cedar Waxwing	F : Upper Canopy Gleaner	Tree-Twig	F : Upper Canopy Gleaner
Northern Shrike			C : Ground Pouncer
Loggerhead Shrike	C : Ground Pouncer	Tree-Twig	C : Ground Pouncer
European Starling	O : Ground Gleaner	Buildings	O : Ground Gleaner
White-eyed Vireo	I : Lower Canopy Gleaner	Tree-Twig	
Solitary Vireo	I : Upper Canopy Gleaner	Tree-Twig	
Yellow-throated Vireo	I : Upper Canopy Gleaner	Tree-Twig	
Warbling Vireo	I : Upper Canopy Gleaner	Tree-Twig	
Philadelphia Vireo	I : Upper Canopy Gleaner	Tree-Twig	
Red-eyed Vireo	I : Upper Canopy Gleaner	Tree-Twig	
Blue-winged Warbler	I : Lower Canopy Gleaner	Ground-Herb	
Golden-winged Warbler	I : Lower Canopy Gleaner	Ground-Herb	
Tennessee Warbler	I : Upper Canopy Gleaner	Ground-Herb	
Nashville Warbler	I : Lower Canopy Gleaner	Ground-Herb	
Northern Parula	I : Upper Canopy Gleaner	Tree-Branch	
Yellow Warbler	I : Lower Canopy Gleaner	Shrub	
Chestnut-sided Warbler	I : Lower Canopy Gleaner	Shrub	
Magnolia Warbler	I : Lower Canopy Gleaner	Tree-Branch	
Cape May Warbler	I : Upper Canopy Gleaner	Tree-Twig	
Black-throated Blue Warbler	I : Lower Canopy Gleaner	Shrub	
Yellow-rumped Warbler	I : Lower Canopy Gleaner	Tree-Branch	O : Lower Canopy Gleaner
Black-throated Green Warbler	I : Upper Canopy Gleaner	Tree-Branch	
Blackburnian Warbler	I : Upper Canopy Gleaner	Tree-Branch	
Pine Warbler	I : Bark Gleaner	Tree-Branch	
Prairie Warbler	I : Lower Canopy Gleaner	Shrub	

Common Name	Summer Foraging	Breeding Substrate	Winter Foraging
Palm Warbler	I : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Bay-breasted Warbler	I : Lower Canopy Gleaner	Tree-Branch	
Blackpoll Warbler	I : Lower Canopy Gleaner	Tree-Branch	
Cerulean Warbler	I : Upper Canopy Gleaner	Tree-Branch	
Black-and-white Warbler	I : Bark Gleaner	Ground-Herb	
American Redstart	I : Lower Canopy Gleaner	Tree-Twig	
Prothonotary Warbler	I : Ground Gleaner	Tree Cavity-Crevise	
Worm-eating Warbler	I : Ground Gleaner	Ground-Herb	
Ovenbird	I : Ground Gleaner	Ground-Herb	
Northern Waterthrush	I : Riparian Gleaner	Riparian Subsurface	
Louisiana Waterthrush	I : Riparian Gleaner	Riparian Subsurface	
Mourning Warbler	I : Ground Gleaner	Ground-Herb	
Common Yellowthroat	I : Lower Canopy Gleaner	Ground-Herb	
Hooded Warbler	I : Lower Canopy Gleaner	Shrub	
Wilson's Warbler	I : Lower Canopy Gleaner	Riparian Ground	
Canada Warbler	I : Lower Canopy Gleaner	Riparian Ground	
Yellow-breasted Chat	O : Lower Canopy Gleaner	Shrub	
Scarlet Tanager	I : Upper Canopy Gleaner	Tree-Twig	
Northern Cardinal	O : Ground Gleaner	Shrub	G : Ground Gleaner
Rose-breasted Grosbeak	O : Lower Canopy Gleaner	Tree-Twig	
Indigo Bunting	I : Lower Canopy Gleaner	Ground-Herb	
Rufous-sided Towhee	O : Ground Gleaner	Ground-Herb	
American Tree Sparrow			G : Ground Gleaner
Chipping Sparrow	O : Ground Gleaner	Shrub	
Field Sparrow	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Vesper Sparrow	O : Ground Gleaner	Ground-Herb	
Savannah Sparrow	O : Ground Gleaner	Ground-Herb	O : Ground Gleaner
Grasshopper Sparrow	O : Ground Gleaner	Ground-Herb	
Henslow's Sparrow	O : Ground Gleaner	Ground-Herb	
Fox Sparrow			G : Ground Gleaner
Song Sparrow	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Lincoln's Sparrow	O : Ground Gleaner	Ground-Herb	
Swamp Sparrow	I : Ground Gleaner	Riparian Ground	G : Ground Gleaner
White-throated Sparrow	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Dark-eyed Junco	O : Ground Gleaner	Ground-Herb	G : Ground Gleaner
Lapland Longspur			G : Ground Gleaner
Snow Bunting			G : Ground Gleaner
Bobolink	O : Ground Gleaner	Ground-Herb	
Red-winged Blackbird	O : Ground Gleaner	Shrub	G : Ground Gleaner
Eastern Meadowlark	I : Ground Gleaner	Ground-Herb	O : Ground Gleaner
Rusty Blackbird	O : Ground Gleaner	Tree-Twig	O : Ground Gleaner
Common Grackle	O : Ground Gleaner	Tree-Branch	O : Ground Gleaner
Brown-headed Cowbird	O : Ground Gleaner	Nest Parasite	G : Ground Gleaner
Orchard Oriole	I : Upper Canopy Gleaner	Tree-Branch	
Northern Oriole	O : Upper Canopy Gleaner	Tree-Twig	
Pine Grosbeak	G : Upper Canopy Gleaner	Tree-Twig	G : Ground Gleaner
Purple Finch	G : Upper Canopy Gleaner	Tree-Branch	G : Ground Gleaner
House Finch	O : Ground Gleaner	Tree-Twig	G : Ground Gleaner
Red Crossbill	G : Upper Canopy Gleaner	Tree-Twig	G : Upper Canopy Gleaner
White-winged Crossbill	G : Upper Canopy Gleaner	Tree-Branch	G : Upper Canopy Gleaner
Common Redpoll			G : Ground Gleaner
Hoary Redpoll			G : Ground Gleaner
Pine Siskin	O : Ground Gleaner	Tree-Branch	G : Ground Gleaner
American Goldfinch	O : Ground Gleaner	Shrub	G : Ground Gleaner
Evening Grosbeak	G : Ground Gleaner	Tree-Twig	G : Ground Gleaner
House Sparrow	G : Ground Gleaner	Buidings	G : Ground Gleaner

Common Name	Summer Foraging	Breeding Substrate	Winter Foraging
Virginia Opossum	O : Ground Forager	Tree Cavity-Crevise	O : Ground Forager
Masked Shrew	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Water Shrew	I : Water Gleaner	Riparian Subsurface	I : Water Gleaner
Smoky Shrew	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Long-tailed Shrew	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Pygmy Shrew	I : Ground Gleaner	Riparian Subsurface	I : Ground Gleaner
Short-tailed Shrew	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Least Shrew	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Hairy-tailed Mole	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Eastern Mole	I : Ground Gleaner	Terrestrial Subsurface	I : Ground Gleaner
Star-nosed Mole	I : Water Gleaner	Riparian Subsurface	I : Water Gleaner
Little Brown Myotis	I : Air Hawker	Buildings	
Keen's Myotis	I : Air Hawker	Tree Cavity-Crevise	
Indiana Myotis	I : Air Hawker	Tree Cavity-Crevise	
Small-footed Myotis	I : Air Hawker	Buildings	
Silver-haired Bat	I : Air Hawker	Tree-Twig	
Eastern Pipistrelle	I : Air Hawker	Cave-Crevise	
Big Brown Bat	I : Air Hawker	Buidings	
Red Bat	I : Air Hawker	Tree-Twig	
Hoary Bat	I : Air Hawker	Tree-Twig	
Eastern Cottontail	H : Ground Grazer	Ground-Herb	H : Bark-Lower Canopy Browser
New England Cottontail	H : Ground Grazer	Ground-Herb	H : Bark-Lower Canopy Browser
Snowshoe Hare	H : Ground Grazer	Ground-Herb	H : Bark-Lower Canopy Browser
European Hare	H : Ground Grazer	Ground-Herb	H : Bark-Lower Canopy Browser
Eastern Chipmunk	G : Ground Forager	Terrestrial Subsurface	
Woodchuck	H : Ground Grazer	Terrestrial Subsurface	
Gray Squirrel	G : Ground Forager	Tree Cavity-Crevise	G : Ground Forager
Red Squirrel	G : Upper Canopy Forager	Tree Cavity-Crevise	G : Ground Forager
Southern Flying Squirrel	G : Ground Forager	Tree Cavity-Crevise	G : Ground Forager
Northern Flying Squirrel	G : Ground Forager	Tree Cavity-Crevise	G : Ground Forager
Beaver	H : Water Grazer	Riparian Subsurface	H : Upper Canopy Browser
Deer Mouse	O : Ground Forager	Terrestrial Subsurface	G : Ground Forager
White-footed Mouse	O : Ground Forager	Terrestrial Subsurface	G : Ground Forager
Southern Red-backed Vole	H : Ground Grazer	Terrestrial Subsurface	H : Ground Forager
Meadow Vole	H : Ground Grazer	Terrestrial Subsurface	H : Ground Forager
Rock Vole	H : Ground Grazer	Terrestrial Subsurface	H : Ground Forager
Woodland Vole	H : Ground Grazer	Terrestrial Subsurface	H : Bark-Lower Canopy Browser
Muskrat	H : Water Grazer	Riparian Subsurface	H : Water Grazer
Southern Bog Lemming	H : Ground Grazer	Ground-Herb	H : Ground Forager
Northern Bog Lemming	H : Ground Grazer	Ground-Herb	H : Ground Forager
Norway Rat	O : Ground Forager	Terrestrial Subsurface	O : Ground Forager
House Mouse	O : Ground Forager	Buildings	O : Ground Forager
Meadow Jumping Mouse	O : Ground Forager	Ground-Herb	
Woodland Jumping Mouse	O : Ground Forager	Ground-Herb	
Porcupine	H : Upper Canopy Browser	Terrestrial Subsurface	H : Upper Canopy Browser
Coyote	O : Ground Forager	Terrestrial Subsurface	O : Ground Scavenger
Red Fox	O : Ground Forager	Terrestrial Subsurface	O : Ground Forager
Gray Fox	O : Ground Forager	Ground-Herb	O : Ground Forager
Black Bear	O : Ground Forager	Cave-Crevise	
Raccoon	O : Ground Forager	Tree Cavity-Crevise	H : Ground Forager
Marten	C : Upper Canopy Pursuer	Tree Cavity-Crevise	H : Upper Canopy Pursuer

Summer Foraging

Breeding Substrate

Winter Foraging

Fisher	C : Upper Canopy Pursuer	Tree Cavity-Crevise	H : Upper Canopy Pursuer
Ermine	C : Ground Pursuer	Ground-Herb	C : Ground Pursuer
Long-tailed Weasel	C : Ground Pursuer	Terrestrial Subsurface	C : Ground Pursuer
Mink	P : Water Diver	Riparian Subsurface	P : Water Diver
Striped Skunk	O : Ground Forager	Terrestrial Subsurface	O : Ground Forager
River Otter	P : Water Diver	Riparian Subsurface	P : Water Diver
Mountain Lion	C : Ground Stalker	Ground-Herb	C : Ground Stalker
Lynx	C : Ground Stalker	Ground-Herb	C : Ground Stalker
Bobcat	C : Ground Stalker	Cave-Crevise	C : Ground Stalker
White-tailed Deer	H : Ground Grazer	Ground-Herb	H : Bark-Lower Canopy Browser
Moose	H : Ground Grazer	Ground-Herb	H : Bark-Lower Canopy Browser

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DeGraaf, Richard M.; Rudis, Deborah D. **New England wildlife: habitat, natural history, and distribution.** Gen. Tech. Rep. NE-108. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1986. 491 p.

Describes natural history profiles of New England wildlife species and their associations with forested and nonforested habitats. Provides a data base that will enable forest managers or wildlife biologists to describe the species or groups to be found in a given habitat.

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Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
 - Berea, Kentucky, in cooperation with Berea College.
 - Burlington, Vermont, in cooperation with the University of Vermont.
 - Delaware, Ohio.
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 - Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
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-

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OPTIGRAMI Users Manual

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Abstract

A computer program called OPTIGRAMI has been developed to determine the optimum, or least-cost, grade mix of hardwood lumber required to produce a given cutting order of furniture dimension parts. If the optimum mix is not available, OPTIGRAMI can be used to determine the next best alternative. The Users Manual describes the steps involved in using the program.

The computer program described in this publication is available on request with the understanding that the U.S. Department of Agriculture cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program. For cost information, please write: Northeastern Forest Experiment Station, Forestry Sciences Laboratory, P.O. Box 152, Princeton, West Virginia 24740.

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OPTIGRAMI is an acronym for OPTimum GRAde Mix. With this computer program, you can determine the optimum, or least-cost, mix of lumber grade volumes required to produce a given cutting order in a furniture rough mill. If this mix is not available, the next best alternative can be determined. OPTIGRAMI can also be used in making decisions on improving lumber use practices, evaluating lumber purchasing policies, and scheduling for the dry-kiln and rough mill. A thorough discussion of how OPTIGRAMI can be used to help solve day-to-day rough-mill decisions is contained in "OPTIGRAMI: Optimum lumber grade mix program for hardwood dimension parts" (Martens and Nivlev 1985). It can be obtained from the Northeastern Forest Experiment Station's Forestry Sciences Laboratory, P.O. Box 152, Princeton, West Virginia 24740. This manuscript is a user's manual describing the simple steps required to run OPTIGRAMI.

OPTIGRAMI was written for the person with little computer experience and is user friendly. Input to the program is straightforward and includes numerous prompts for the user's benefit.

Because the program is designed for use on any IBM mainframe computer with a mathematical programming system (MPS) in its program library, access can be through an on-site computer or through a remote terminal.

Remote Terminal

For those wishing to use a remote terminal, OPTIGRAMI has been placed on the Computerized Management Network (CMN), a national time-sharing computer service managed by the Virginia Cooperative Extension Service. The CMN software library contains many other problem-solving programs and resides on the computer at Virginia Polytechnic Institute and State University (VPI&SU), Blacksburg, Virginia. Information on accessing CMN is provided at the end of this section.

To make OPTIGRAMI run, you simply enter the command "OPTIGRAMI". The main menu, shown in Figure 1, will appear on your screen and indicate your options. By pressing one of four function (PF) keys, you can request a file for editing or analysis, determine if a submitted analysis has been returned to your user, edit the HELP file, or exit the program.

Consequently, if you wish to make an OPTIGRAMI analysis, you press the PF4 key. The screen will read "enter file name" (Fig. 2). It also lists the file names that you have previously run. To enter a file name, you may either (a) enter a name of from one to eight characters in the file name field and then press the ENTER key, or (b) position the cursor at the name of one of your existing files and then press ENTER (this copies the name at the cursor to the file name field at the top of the screen); then press ENTER again to validate the name you have selected. A message will appear at the bottom of the screen indicating that the requested file is an old file.

Now that you have selected your file, press the PF8 key, as shown at the bottom of the screen, to proceed to the File Options screen (Fig. 3). As shown, you press a PF key to select whether you want to edit the selected file (PF4), submit the file for processing (PF5), or specify your job priority (PF6).

Our example shows that we are interested in making an analysis, so press PF4 to proceed to the Data Entry screen (Fig. 4). Fields for all necessary data input are labeled. These include date, cutting order name, species, thickness, lumber grades to be selected and their respective costs, yield adjustments, and volume constraints. On the data entry screens, you can move the cursor with the cursor controls or skip from field to field with the TAB key.

Our example Data Entry screen (Fig. 5), specifies hard maple lumber, 4/4 thickness, and Grades No. 2 Common, No. 1 Common, and First and Seconds (FAS). The input cost for each grade, expressed in dollars per M bf (thousand board feet), is the sum of all costs through the rough mill. Cost items to be included are at the discretion of the user but might include the costs for lumber, delivery, drying and handling, rough-mill processing and overhead inventory, and inspection.

The predicted yield values that form the basis for the OPTIGRAMI analysis are those developed by the USDA Forest Service's Forest Products Laboratory (Englerth and Schumann 1969). These yields were developed for hard maple lumber, but they can be applied to most species graded by the National Hardwood Lumber Association rules.

Selected File: CSQUIRE

Press the PF key corresponding to your choice

PF4 - Edit the Selected File

PF5 - Submit the file for processing.

PF6 - Specify job priority.
(Use before submitting a job.)

PF1 = Help PF3 = Quit PF7 = Return to File Specification Panel

Figure 3.—File option screen.

===== OPTIGRAM ===== Data Entry =====

Date	Name of Cutting Order		Species	Thickness
	Lumber Grade Information (Select only three)			
Input Factors	2C	1C	C&B	SEL FAS
Cost (\$/MBF)	---	---	---	---
Yield Adj. (Percent)	---	---	---	---
Volume Constraints (MBF)	---	---	---	---

PF1 = Help PF3 = Exit PF7 = Prev. Screen PF8 = Next Screen

Figure 4.—Blank data entry screen.

```

=====> OPTIGRAM <===== Data Entry =====
1 / 30 / 85  COUNTRY SQUIRE SUITE  HARD MAPLE  4 / 4
-----
Date          Name of Cutting Order      Species      Thickness

Input
Factors

Lumber Grade Information
(Select only three)

      2C      1C      C&B      SEL      FAS

Cost ($/MBF)      570.00      835.00      -----      -----      1020.00
-----

Yield Adj.      100.0      100.0      -----      -----      100.0
(Percent)      -----

Volume Constraints      0.000      0.000      -----      -----      0.000
(MBF)      -----

PF1 = Help    PF3 = Exit    PF7 = Prev. Screen    PF8 = Next Screen

```

Figure 5.—Completed data entry screen.

Experience with using these yields indicates that it may be appropriate to adjust these yield values to reflect actual rough-mill efficiency, heavier thicknesses of lumber, admissible defects, specific species characteristics, or very stringent quality control specifications.

Recommended percent yield reductions (Dunmire 1971) for thicknesses over 4/4 are:

Grade	Lumber thickness in inches		
	5/4	6/4	8/4
FAS	2	3	4
SEL	3	4	5
1C	3	4	5
2C	4	5	6

Dimension yields are based on clear-one-face parts. The recommendation for percent yield reduction for clear-two-face parts is 2 percent.

Our example (Fig. 5) shows that we made no yield reductions; consequently, it reads 100.0 percent. If we had wanted to reduce a specific grade by 8 percent, we would have entered 92.0 in the yield adjustment field for that grade.

Note that the yield tables will accommodate cutting lengths from 10 to 96 inches and specified widths up to 6 inches. However, the maximum length that can be derived from a specific grade is 96 inches for FAS and Select, 90 inches for No. 1 Common and Better (C&B), 80 inches for No. 1 Common, and 40 inches for No. 2 Common. Yields for C&B are based on a mixture of 25 percent FAS, 25 percent Selects, and 50 percent No. 1 Common.

Likewise, our example does not indicate any volume constraints. If we had a limited amount of one of our grades available, say 8 M bf, we would have entered 8.000 in the volume constraint field for that grade. The optimum grade mix may or may not use any of that grade, but it would not indicate more than 8 M bf of it in the solution.

We now press PF8 to move to the next screen, which is where we enter our cutting order (Fig. 6). OPTIGRAM can accommodate 50 specific cutting sizes—30 on this screen and 20 on the next screen (Fig. 7). Each is entered by length, width, type, and number of pieces. Type of part is indicated by an R or S. R is used for panels that will be glued up from random width pieces, and S is used when each part is to have a specified width. Part sizes do not need to be entered in any particular order.

Pressing the PF8 key takes us to screen 2 of the cutting order (Fig. 7), and pressing PF8 again takes us back to the File Options screen (Fig. 3). If we press PF4 on the File Options screen, we can specify our job priority (Fig. 8). Five levels of priority can be selected: low (least expensive) to urgent (most expensive). If a selection is made, the program is set to run on that priority.

Assuming that we are satisfied with our priority, we press PF5 to submit our file for processing. We will receive a message at the bottom of the screen indicating that "OPTIGRAM job submitted. Check for results after 10 minutes."

We can now press PF4 to make changes in our file if we want to rerun it with different lumber input costs, yield adjustments, or volume constraints. If we want to enter another analysis, we can press PF7 to go back to the File Specification screen (Fig. 2).

To receive OPTIGRAM output, return to the Main Menu screen (Fig. 1) and press the PF5 key to determine if the submitted analysis has been returned to your user. If it has not come back, a message at the bottom of the screen says "No OPTIGRAM output has been returned. Try again later." If the output has

CUTTING ORDER									
Item No.	Length (in.)	Width (in.)	R/S*	Number of Pieces	Item No.	Length (in.)	Width (in.)	R/S*	Number of Pieces
(1)	48.250	20.000	R	360	(2)	30.000	19.000	R	608
(3)	87.750	2.250	S	406	(4)	80.375	2.250	S	200
(5)	64.375	2.250	S	200	(6)	56.000	3.250	S	1850
(7)	33.125	4.125	S	844	(8)	28.250	3.000	S	130
(9)	23.500	4.000	S	1850	(10)	22.750	2.250	S	300
(11)	21.000	4.250	S	550	(12)	19.500	2.750	S	470
(13)					(14)				
(15)					(16)				
(17)					(18)				
(19)					(20)				
(21)					(22)				
(23)					(24)				
(25)					(26)				
(27)					(28)				
(29)					(30)				

PF1 = Help PF3 = Exit PF7 = Prev. Screen PF8 = Next Screen

Figure 6.—Cutting order (screen 1).

CUTTING ORDER (Screen 2)									
Item No.	Length (in.)	Width (in.)	R/S*	Number of Pieces	Item No.	Length (in.)	Width (in.)	R/S*	Number of Pieces
(31)					(32)				
(33)					(34)				
(35)					(36)				
(37)					(38)				
(39)					(40)				
(41)					(42)				
(43)					(44)				
(45)					(46)				
(47)					(48)				
(49)					(50)				

PF1 = Help PF3 = Exit PF7 = Prev. Screen PF8 = Go to File Options Screen

Figure 7.—Cutting order (screen 2).

```

===== OPTIGRAM JOB PRIORITY =====
Mark an 'X' next to the priority you want assigned to your job.

      IDLE                (Least expensive)
      -
      OVERNITE
      -
      STANDARD
      -
      PRIORITY
      -
      URGENT              (Most expensive)
      -

                                PF7= Return to Menu
  
```

Figure 8.—OPTIGRAM job priority.

turned, it will indicate that it is in your reader. To look at the output, press PF11 as indicated on the screen. This makes the entire OPTIGRAMI output available to you. You can look through it by pressing the PF8 and PF7 keys to scroll forward and backward, respectively.

The OPTIGRAMI output is divided into four sections. The first is the input information section (Fig. 9) that provides a record of the input data used in the analysis. Included are the date, cutting order name, species, thickness, lumber costs for each grade, any yield adjustments or volume constraints used, and a listing of the cutting order.

The next two sections (Fig. 10) provide the least-cost grade mix required to produce the cutting order and the range and sensitivity analysis information. The optimum grade mix provides the amount of each grade required, the cost of each grade based on the input costs, the net board feet of cuttings expected from each grade, and the expected percent yield of each grade. The same information is provided for the total cutting order.

The range and sensitivity analysis provides information on how sensitive the least-cost grade mix is to changes in the input cost of the various grades. It shows the range over which the input cost of each grade can move without a change in the least-cost grade mix, assuming that the input cost of the other grades remains constant. It also shows, for each grade, the input cost at which there would be an alternative least-cost grade mix and the associated gross volume. It indicates how much lumber of that grade would be used in the alternative mix. For instance, the example shows an input cost for No. 1 Common lumber of \$835 per M bf, and the least-cost solution uses 5.298 M bf of it. However, the lower limit of the input cost range for No. 1 Common indicates that if the input cost decreased to \$834.23 per M bf, assuming that the input costs of the other grades remained unchanged, there would be an alternative least-cost grade mix that used 1281 M bf of No. 1 Common lumber. In other words, at that input cost, two combinations of grades have identical total costs. However, one combination uses almost twice as much No. 1 Common lumber as the other. For a more complete discussion of the interpretation of the range and sensitivity analysis and how it can be used as a tool in making management decisions, obtain a copy of the OPTIGRAMI report (Martens and Nevel 1985) mentioned earlier.

The final part of the printout is the "Optimum Solution Cutting Information" (Fig. 11). It describes how the required cuttings can be obtained from the optimum grade mix. For each grade used, it shows the gross volume of rough lumber required, the cutting sizes to be obtained, the expected number of each size cutting to be obtained, and the anticipated quantity of each cutting obtained.

It also provides the board feet of shorts anticipated from each grade. The shorts figure represents the unused net board footage of 10-inch-long cuttings that would be available from each grade. As such, it indicates how well the raw material is being used.

In addition to information on each lumber grade, this section also summarizes information for the entire cutting order. Included in the summary are total gross volume of lumber required, the net board feet of cuttings to be obtained, the total board feet of shorts anticipated, and the total number of pieces required.

The "Optimum Solution Cutting Information" section would normally be given to the rough mill foreman for his use in assigning cutting lengths to specific saw operators. Generally, the longer length cuttings are derived from a single grade, the medium length cuttings from a combination of two grades, and the shorter length cuttings from all grades.

If you wish to keep the output, press the PF9 key to transfer it to your CMN disk space as a permanent record or to have it printed. If you have a printer attached to your terminal, you can have your results printed by using the command "TPRINT" followed by the file name that you used in your file name screen shown in Figure 2. You can also discard the output by pressing the PF2 key or have it printed at VPI&SU by pressing the PF4 key. VPI&SU will send you the results. By pressing the PF3 key, you will return to the Main menu.

On every screen requiring the selection of an option or the input of data, the PF1 key has been labeled HELP. By pressing it, a help file will be displayed on the screen to explain each of the options available to you.

CMN can be accessed with any ASCII terminal and a modem. You also can use a microcomputer with a communications program as a terminal. When accessing CMN by dialing the computer directly via long distance telephone lines, you must have a CMN userid and password. These can be obtained by contacting:

Virginia Polytechnic Institute and State University
Virginia Cooperative Extension Service
Extension Computing Resources
Plaza I, Building D
Blacksburg, Virginia 24061
(703) 961-5184

There is no initial fee or hookup charge for CMN. However, there is a small monthly userid ownership charge. Each CMN userid receives a monthly billing that includes a complete listing of all charges for each time CMN was used. Also upon completion, every CMN program displays the cost for using the program. The total cost for a CMN session is displayed when

Figure 9

Input Information Section of OPTIGRAMI Printout

July 10, 1984—COUNTRY SQUIRE SUITE—HARD MAPLE^a

LUMBER GRADE ^b	PRODUCTION COSTS ^c (Dollars/M bf)	GRADE YIELD ADJUSTMENT FACTOR ^d	VOLUME CONSTRAINTS ^e (M bf)	LUMBER THICKNESS ^f (Inches)
NUMBER 2 COMMON	570.00	100.0	None	4/4
NUMBER 1 COMMON	835.00	100.0	None	4/4
FIRST AND SECONDS	1020.00	100.0	None	4/4

INPUT CUTTING ORDER

CUTTING SIZE		TYPE OF CUTTING RANDOM (R) OR SPECIFIED (S)	NUMBER OF CUTTINGS	NET BOARD FEET OF CUTTINGS
LENGTH	WIDTH			
(Inches)	(Inches)			
48.250	20.000	R	360	2412.5
30.000	19.000	R	608	2406.7
87.750	2.250	S	406	556.7
80.375	2.250	S	200	251.2
64.375	2.250	S	200	201.2
56.000	3.250	S	1850	2338.2
33.125	4.125	S	844	800.9
28.250	3.000	S	130	76.5
23.500	4.000	S	1850	1207.6
22.750	2.250	S	300	106.6
21.000	4.250	S	550	340.9
19.500	2.750	S	470	175.0
Total			7768	10873.9

^a Cutting order identification, species, and date.^b Standard lumber grades chosen to be evaluated.^c Total production cost per M bf assigned to each grade.^d Adjustment made to the yield of each grade.^e Volume constraints imposed on each grade.^f Lumber thickness being considered.

Figure 10 Least-Cost Grade Mix Solution and Range and Sensitivity Analysis

Information Sections of OPTIGRAMI Printout

LEAST-COST GRADE MIX SOLUTION

July 10, 1984—COUNTRY SQUIRE SUITE—HARD MAPLE^a

SUMMARY BY GRADE

SELECTED GRADES ^b	INPUT COST/M bf ^c (Dollars)	GROSS VOLUME ^d (M bf)	TOTAL PRODUCTION COST ^e (Dollars)	BOARD FEET OF CUTTINGS ^f	PERCENT YIELD ^g
NUMBER 2 COMMON	570	7.268	4142	3541.4	48.7
NUMBER 1 COMMON	835	5.298	4424	3378.1	63.7
FIRST AND SECONDS	1020	5.855	5972	3954.5	67.5
TOTALS		18.421	14538	10873.9	59.0

RANGE AND SENSITIVITY ANALYSIS INFORMATION

SELECTED GRADES	INPUT COST AND LEVELS/M bf ^h (Dollars)	ASSOCIATED GROSS VOLUMES (M bf) ⁱ
NUMBER 2 COMMON	Upper	572.59
		570.00
	Lower	559.27
NUMBER 1 COMMON	Upper	851.64
		835.00
	Lower	834.23
FIRST AND SECONDS	Upper	1021.18
		1020.00
	Lower	1009.27

Identifying name or title of the cutting order, species, and date.

Standard lumber grades chosen to be evaluated by OPTIGRAMI.

Total production cost per M bf assigned to each grade.

Quantities of each grade contained in the least-cost grade mix.

Total costs for the amount of each grade of lumber used in the least-cost mix.

Quantity of cuttings expected from each grade.

Anticipated percent yield to be obtained from each grade.

Range of input costs for each grade.

Volume of that grade used in the alternate least-cost grade mix at that level of input cost.

Figure 11

Optimum Solution Cutting Information Section of OPTIGRAMI Printout

OPTIMUM SOLUTION CUTTING INFORMATION

July 10, 1984—COUNTRY SQUIRE SUITE—HARD MAPLE

SELECTED GRADES	LUMBER THICKNESS (Inches)	GROSS VOLUME (M bf)	CUTTING SIZE ^a LENGTH WIDTH - - - - (Inches) - - - -		TYPE OF CUTTING	NUMBER OF CUTTINGS ^b	NET BOARD FEET
NUMBER 2 COMMON	4/4	7.268					
			30.000	19.000	R	608	2406.7
			28.250	3.000	S	130	76.5
			23.500	4.000	S	1117	729.2
			22.750	2.250	S	300	106.6
			21.000	4.250	S	172	106.4
			19.500	2.750	S	311	116.0
NET BOARD FEET/GRADE ^d = 3541.4							
BOARD FEET SHORTS ^e = 625.0							
NUMBER 1 COMMON		5.298					
			48.250	20.000	R	360	2412.5
			64.375	2.250	S	200	201.2
			33.125	4.125	S	202	191.8
			23.500	4.000	S	733	478.5
			21.000	4.250	S	91	56.4
			19.500	2.750	S	101	37.7
NET BOARD FEET/GRADE = 3378.1							
BOARD FEET SHORTS = 217.2							
FIRST AND SECONDS		5.855					
			87.750	2.250	S	406	556.7
			80.375	2.250	S	200	251.2
			56.000	3.250	S	1850	2338.2
			33.125	4.125	S	642	609.0
			21.000	4.250	S	287	178.1
			19.500	2.750	S	57	21.3
NET BOARD FEET/GRADE = 3954.5							
BOARD FEET SHORTS = 140.5							
TOTAL GROSS VOLUME	TOTAL NET BOARD FEET		TOTAL SHORTS		TOTAL NUMBER OF PIECES		
(M bf)			(bf)				
18.421	10873.9		982.8		7768		

^a Cuttings obtained from each grade in the least-cost solution.^b Expected number of each cutting to be obtained from each grade.^c Anticipated quantity of each cutting obtained from each grade.^d Total quantity of all cuttings expected from each grade.^e Cumulative unused net board footage of 10-inch-long cuttings available in each grade.

enter the LOGOFF command. You may also determine the total charges incurred at any point in the CMN session by entering the command "CHARGES".

When you contact the Extension Computing Resources staff at VPI&SU, they will assign you a userid that consists of five characters followed by a numerical code. You will select your own password that will be known only to you. It must consist of five to eight characters and, for security reason, ought to be changed periodically.

When you LOGON with your CMN userid and password, you will have access to more than 60 programs contained in the CMN library. They cover a broad range of subjects including crop and farm management, general finance and accounting, taxes and estate planning, machinery and equipment, and information retrieval.

Although the use of OPTIGRAMI may seem confusing, it is really very easy to follow and operate. Should any question arise, the HELP files will provide the answer.

Mainframe

Potential users who have access to an IBM mainframe computer may obtain a copy of our OPTIGRAMI program library by sending a blank tape to the Forestry Sciences Laboratory, P.O. Box 152, Princeton, West Virginia 24740. We will have the library copied onto it and return it to sender with documentation of its contents. There will be no charge to the user.

If the IBM mainframe in question does not have a Mathematical Programming System (MPS) in its program library, it will be necessary to obtain it before OPTIGRAMI will function. An MPSX can be obtained from an IBM representative or an MPSIII can be obtained from KETRON, Inc., Management Science System Division, 1400 Wilson Boulevard, Arlington, Virginia 22209.

Acknowledgments

We greatly appreciate the cooperation of members of the faculty of the School of Forest Resources, North Carolina State University, who provided guidance and technical support during this study. We also thank USDA Forest Service employees Daniel E. Dunmire, III, and Edward K. Pepke for their help in demonstrating the concept's validity in industrial situations through the Rough Mill Improvement Program.

Literature Cited

Dunmire, Daniel E., III. **Predicting yields from Appalachian red oak logs and lumber.** In: Oak symposium proceedings; 1971 August 16-20; Morgantown, WV. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1971. 94-99.

Englerth, George H.; Schumann, David R. **Charts for calculating dimension yields from hard maple lumber.** Res. Pap. FPL-118. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1969. 12 p.

Martens, David G.; Nevel, Robert L., Jr. **OPTIGRAMI: Optimum lumber grade mix program for hardwood dimension parts.** Res. Pap. NE-563. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 10 p.



Martens, David G.; Whitenack, Kenneth R.; Nevel, Robert L., Jr. **OPTIGRAMI users manual**. Gen. Tech. Rep. NE-109. Broomall, PA. U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1986. 11 p.

A computer program called OPTIGRAMI has been developed to determine the optimum, or least-cost, grade mix of hardwood lumber required to produce a given cutting order of furniture dimension parts. If the optimum mix is not available, OPTIGRAMI can be used to determine the next best alternative. The Users Manual describes the steps involved in using the program.

ODC 836.1

Keywords: Furniture; hardwood dimension; lumber yields; dimension yields

Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

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Adams, Edward L. **DESIM: A system for designing and simulating hardwood sawmill systems.** Gen. Tech. Rep. NE-89. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 10 p.

DESIM is a new system for designing and simulating the operation of hardwood sawmill systems. Sections are oriented on: (1) the system, (2) required inputs, and (3) resulting outputs. This computer system is relatively easy to use for even a very complex sawmilling situation.

Adams, Edward L. **DESIM user's manual: a procedural guide for designing and simulating hardwood sawmill systems.** Gen. Tech. Rep. NE-94. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 58 p.

A procedural guide for using the DESIM computerized system for designing and simulating the operation of hardwood sawmill systems. Instructions are provided for everything from setting up the DESIM system on a computer to simulating the operation of a proposed sawmill system. This user guide makes the system relatively easy to use for even complex sawmill situations.

Aranson, R. Bruce; Luppold, W. G.; Wallin, W. B. **Assessing pallet industry use of the low-grade southern hardwood resource.** In: Payoffs from new techniques for managing and processing southern hardwoods: 1984 Southern Forest Economics Workshop; 1984 March 13-15; Memphis, TN. Raleigh, NC: SOFEW; 1984: 87-97.

In the next two decades, we will see an increase in the utilization of the southern low-grade hardwood resource because of the continued growth in the use of pallets in materials handling systems. This growth is encouraged by the great cost savings realized in shipping and handling of products on pallets. Cost savings are due, in part, to the availability of low-cost raw materials for pallet production. The low-grade sawtimber, pole timber, and pulpwood portion of the resource, underutilized at present, will become increasingly important in meeting the needs of the pallet industry in the decades to follow.

Araman, Philip A.; Dempsey, Gilbert P. **The U.S. hardwood forest resource situation and our hardwood timber and dimension market potentials in Europe.** In: Dickerhoof, H. Edward, ed. International forest products trade: resources and market opportunities. Proceedings of a conference; 1983 November 7-9;

Arlington, VA. Madison, WI: Forest Products Research Society; 1984: 124-132.

Reviews the hardwood resources in standing sawtimber and at sawmills, and describes the grade distribution of lumber produced. Looks at the history of hardwood exports to Europe and the economic conditions that both aid and hinder export efforts. Presents some projections of future demand along with thoughts on the United States' potential to meet these expectations, as well as action to take to increase hardwood exports.

Araman, Philip A.; Reynolds, Hugh W. **Producing standard-size blanks from lower grade hardwoods: A case report.** In: Dempsey, Gilbert P.; Price, Karen S., eds. Governor's conference on West Virginia's forest industry. Workshop proceedings; 1983 November 7-8; Charleston, WV. Charleston, WV: Governor's Office of Economic and Community Development and West Virginia Forests, Inc.; 1984: 123-126b.

Ashby, W. C.; Vogel, W. G.; Kolar, C. A.; Philo, G. R. **Productivity of stony soils on strip mines.** In: Proceedings, Erosion and productivity of soils containing rock fragments; 1982 November 28-December 3; Anaheim, CA. SSSA Spec. Publ. No. 13. Madison, WI: Soil Science Society of America; 1984: 31-44.

Stone content is only one of many factors changed during mining and reclamation. Because so many factors are changed, assessments of the role of stone must often be partly or largely inferred. Experimentation with presence or absence of stones on mine soils as a single variable has not been carried out to our knowledge. The potential for productive mine soils with stones has been well documented. The purpose of our study was to determine how much rock fragment is found in mine-soils, and how the fragment content affects vegetative productivity. We concluded that mine soils with differing content of coarse fragments may have productivity equal to or greater than pre-mining soils.

Auchmoody, L. R.; Rexrode, C. O. **Black cherry site index curves for the Allegheny Plateau.** Res. Pap. NE-549. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 5 p.

Black cherry site index curves were developed for the Allegheny Plateau in northwestern Pennsylvania. They show for this region that height rises less sharply prior to the index age and is maintained for a longer period thereafter than described by existing curves. An equation to predict site index from height and age is furnished to allow the use of these curves in computer processing. For field use, a table of site indexes by 2-foot heights and 2-year ages is provided.

Baker, C. Jacyn; Melhuish, John H., Jr. **Separation of unsaturated fungal fatty acid methyl esters by reversed-phase liquid chromatography for further evaluation by gas chromatography.** Journal of Chromatography. 284: 251-256; 1984.

The objective of this study was to optimize conditions for separation and recovery of unsaturated C₁₆ and C₁₈ fatty acid methyl esters. Two reversed-phase columns

were tested, a Perkin-Elmer Cg and a DuPont Zorbax ODS (C₁₈). The latter column was better suited for our particular needs. The optimal system was then used to separate fatty acids extracted from Athelia bicolor.

Barger, J. H. **Hydraulic sprayer applications of methoxychlor on American elm.** In: Mayo, Z. B., compiler. Proceedings, 39th annual meeting, North Central Branch of Entomological Society of America; 1984 March 26-29; Wichita, KA. College Park, MD: North Central Branch of Entomological Society of America; 1984. Abstract 100.

Barger, Jack H. **Evaluation of hydraulically applied methoxychlor to protect American elms from feeding by the European elm bark beetle (Coleoptera: Scolytidae).** Journal of Economic Entomology. 77: 794-797; 1984.

American elm trees were sprayed by hydraulic sprayer with various concentrations of methoxychlor, with and without stickers, in different seasons and cities to determine chemical deposit and efficacy against the smaller European elm bark beetle, a vector of the Dutch elm disease fungus. Gas-liquid chromatography assays and beetle bioassays were used to quantify methoxychlor deposits. Methoxychlor deposit was unaffected by the addition of spray sticker but weathering, season sprayed, concentration and skill of the spray crew significantly affected deposit.

Barger, Jack H.; Cuthbert, Roy A.; Cannon, William N., Jr. **Numbers of Scolytus multistriatus (Coleoptera: Scolytidae) caught on multilure-baited sticky traps increase with Methoxychlor.** Journal of Economic Entomology. 77: 1251-1253; 1984.

Multilure-baited sticky traps were attached to various methoxychlor-sprayed and unsprayed trap sites to determine the effect of the insecticide treatments on catches of the smaller European elm bark beetle. Significantly more bark beetles were captured by baited sticky traps attached to the boles of sprayed healthy American elms, and also by traps attached to the boles of sprayed elms infected with the Dutch elm disease fungus, than were captured by traps on comparable unsprayed elms. Bark beetle catches on traps attached to sprayed and unsprayed utility poles and tree trap sites other than elms were not significantly different. These tests suggest that other beetle attractants associated with healthy and diseased elms and the presence of methoxychlor on the trap sites significantly affected trap catches.

Barnard, Joseph E. **Forest inventory and analysis in the Northeast.** In: Proceedings of the forest land inventory workshop, Preparing for the 21st Century; 1984 March 26-30; Denver, CO. Washington, DC: USDA Forest Service, Division of Timber Management; 1984: 79-85.

The Northeastern Forest Experiment Station has conducted forest resource inventories since the mid-1940's. The third cycle of these inventories is nearing completion. All cycles have used double sampling procedures that involved both the photo interpretation of many points and the ground examination and measurement of a subsample of these photo locations. Since 1960, the Station has used the Sampling with Partial Replacement

design as the basic framework of each state inventory. Details of the application of the design and modifications to increase the level of resolution of the data are discussed in detail.

Baumgras, John E. **Predicting product yields from thinnings in Appalachian hardwoods.** Journal of Forestry. 82(1): 43-46; 1984.

Equations have been developed for estimating the volume per acre of sawlogs, sawbolts, and pulpwood or fuelwood that can be harvested by thinning hardwood stands of poletimber or small sawtimber size. The equations were derived from actual roundwood yields obtained by thinning 17 stands of Appalachian hardwoods in Virginia and West Virginia, and measuring the product volume of each cut tree 5.0 inches d.b.h. or larger. If the amount of basal area to be removed in a 2-inch d.b.h. class is known, the equations facilitate estimates of alternative yields from thinnings and identify opportunities for multiproduct harvesting.

Beckjord, P.; Melhuish, J., Jr.; McIntosh, M. **Influence of nitrogen and phosphorus fertilization on ectomycorrhizal formation of Quercus alba and Q. prinus seedlings by Pisolithus tinctorius and Sclerotium auranteum.** In: 6th North American conference on ectomycorrhizae; 1984 June 25-29; Bend, OR. (Publication unknown): (Publisher's name unknown); 1984.

The purpose of the study was to determine what optimum amount of nitrogen or phosphorus (or both in combination) would be necessary to maximize ectomycorrhizal formation on oak seedlings.

Beckjord, Peter R.; McIntosh, Marla S.; Haeskaylo, Edward; Melhuish, John H., Jr. **Inoculation of loblolly pine seedlings at planting with Basidiospores of ectomycorrhizal fungi in chip form.** Res. Note R-324. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.

Basidiospores of the ectomycorrhizae-forming fungus Pisolithus tinctorius and Sclerotium auranteum incorporated into an organic hydrocolloid can be used successfully in field inoculation. Containerized loblolly pine seedlings were inoculated during outplanting by this method. This study showed that basidiospore inocula were effective inocula in this investigation.

Benzie, John W.; Smith, Thomas M.; Frank, Robert **Balsam fir.** In: Final environmental impact statement for regional guide--Eastern Region. Milwaukee, WI: U.S. Department of Agriculture, Forest Service, Eastern Region; 1984: D22-28.

Billar, Cleveland J. **Testing the FMC-180CA high-speed steel track logging vehicle.** In: Proceedings of Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 215-225.

The FMC FT-180CA high-speed steel track logging vehicle was field tested on the George Washington National Forest near Covington, Virginia. Pulpwood and sawlogs were harvested in the clearcut operation. The average volume per turn was 102 cubic feet of Appalachian hardwoods. Skidding was uphill; maximum

average grade was 44 percent. An average skid of 1,190 took 14.9 minutes.

Mr. Cleveland J.; Fisher, Edward L. **Whole-tree harvesting with a medium capacity cable yarder.** Transactions of the ASAE. 27(1): 2-4; 1984.

The study was conducted to monitor productive and unproductive times during logging with a medium-capacity cable yarder harvesting whole hardwood trees in clearcut. Prediction equations were developed to estimate the cycle time for the yarder, and yarding cost was calculated at \$3.33/m³ (\$7.33/cord @ 78 m³/cord) for whole-tree chips.

Mr. Thomas W. **The private forest-land owners of the United States.** In: New forests for a changing world: Proceedings, Convention of the 1983 Society of American Foresters; 1983 October 16-20; Portland, OR. SAF Publ. 84-03. Bethesda, MD: Society of American Foresters; 1984: 626-630.

Nearly 7.8 million private owners have 333 million acres of forest land in the United States. A 1978 survey shows that half of the forest land is in ownerships greater than 500 acres and this land is owned by less than 1 percent of the owners. An additional 30 percent of the private forest land is in ownerships of 100 to 500 acres, many of these ownerships could produce substantial amounts of timber on a continuing basis. Quantifying the diversity of ownerships is the first step to better understanding this important group of decision-makers. Matching compatible owner objectives with opportunities for intensive timber management has been perceived as a major stumbling block to increased productivity. This issue can now be addressed in a more qualitative context.

Mr. Thomas W. **Private forest-land owners of New York.** National Woodlands. 7(5): 8-10; 1984. Only four percent of New York's 15.4 million acres of commercial forest land is in 506,500 private ownership. Of the private owners, 53 percent have fewer than 10 acres of forest land, and they own 6 percent of the private forest land. Fewer than 1 percent of the owners have more than 500 acres of forest, and they own 10 percent of the forest land in New York. Benefits other than timber production are important to most owners. However, these owners are not opposed to harvesting trees from their land. The availability of private land for timber production has improved since 1966.

Mr. Barton M. **Selection system of silviculture in spruce-fir.** Forest Technique. 84(8): 10; 1984. Describes the advantages and disadvantages of the selection system in spruce-fir stands. When used properly, the selection method perpetuates a well-stocked stand of the more vigorous, fast-growing, and well-formed trees distributed among all age classes.

Mr. Barton M. **U.S. Forest Service research—alive and well in Maine.** National Woodlands. 7(4): 8-10; 1984.

The Orono, Maine, Research Unit of the USDA Forest Service's Northeastern Forest Experiment Station has been conducting research activities in the forests of Maine since 1950. This research has concentrated pri-

marily on the spruce-fir forest type, including associated species such as white pine, hemlock, and northern hardwoods. The Orono unit is responsible for planning, establishing, and maintaining research studies on the Penobscot Experimental Forest, and administering logging operations and maintaining roads and boundaries.

Brann, Thomas B.; Solomon, Dale S. **Spruce budworm growth impact study.** In: Houseweart, Mark W.; Seymour, Robert S., eds. 1983 annual report of the Cooperative Forestry Research Unit. Orono, ME: University of Maine at Orono, Maine Agricultural Experiment Station; 1984; Misc. Rep. 298. 33 p.

Branson, Branley A.; Batch, Donald L.; Curtis, Willie R. **Small-stream recovery following surface mining in east-central Kentucky.** Transactions of the Kentucky Academy of Science. 45(1-2): 55-72; 1984. Analyses of physio-chemical, piscine, and macrobenthological data secured from two small-stream drainages affected by surface mining in eastern Kentucky are presented.

Brewer, Les; Berrier, Debbie. **Photographic techniques for monitoring resource change at backcountry sites.** Gen. Tech. Rep. NE-86. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 13 p. Resource change can be monitored using photographic methods. Both microsite and macrosite techniques suitable for backcountry use are described and discussed in detail. The microsite techniques, including quadrat photography, trail mosaics, and photographic trail transects, are generally the more expensive, requiring more time or specialized equipment in the field or lab than microsite techniques. The data obtained are detailed and quantifiable to a degree that may be acceptable for research purposes. Macrosite techniques, including panoramas and the monoscopic perspective grid technique, are less likely to provide research data, but are useful for qualitative assessments.

Briggs, Russell D.; Czapowskyj, M. M.; White, E. H. **Effects of fertilization on the nutrient distribution of aboveground components of *Abies balsamea* (L.) Mill.** Plant and Soil. 80: 433-439; 1984.

The following fertilizer treatments were applied to a 20-year-old aspen/birch/spruce-fir stand in southeastern Maine: N at 448 kg/ha, P at 112 kg/ha, N and P applied as above in addition to 1,751 kg/ha Ca and 27 kg/ha Mg. Five years after treatment, foliar concentrations of N, P, and Ca for understory balsam fir exhibited significant increases in response to fertilization with those nutrients. Mean 5-year height growth, adjusted for pretreatment differences, increased 36 percent in response to fertilization with N alone and in combination with P and lime.

Brooks, Robert T.; Rowntree, Rowan A. **Forest area characteristics for metropolitan and nonmetropolitan counties of three Northeastern states of the United States.** Urban Ecology. 8: 341-346; 1984.

Analysis of county-level forest area statistics for 208 counties in New York, Pennsylvania, and Ohio shows: (1) All counties have substantial forest acreage regardless of the degree of urbanization; even counties with

urban centers are more than 30 percent forested; and (2) forest area distribution by stand-size class shows no clear association with the degree of urbanization in the county.

Brooks, Robert T.; Sykes, Karen J. **Sampling land use edge from aerial photographs—line transect vs. circular pattern.** Res. Note NE-321. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 9 p. Compares the diagonal line-transect and circular pattern for sampling land use edge. There were no significant differences in sampling efficiency.

Bullard, Allan T.; Donley, David E. **Current status and potential spread of the gypsy moth to the southern Appalachians.** Tech. Pap. 84-P-9. Washington, DC: American Pulpwood Association, Inc.; 1984. 3 p. The range of the gypsy moth is expanding and will continue to expand until it eventually occupies all of the hardwood production areas of the United States. Our challenge as managers is to plan for this and to learn when and how to intervene to protect our resources.

Buso, Donald C.; Martin, C. Wayne; Hornbeck, James W. **Potential for acidification of six remote ponds in the White Mountains of New Hampshire.** Res. Rep. No. 43. Durham, NH: Water Resources Research Center, University of New Hampshire; 1984. 157 p.

The chemical characteristics of six remote ponds and their inlet streams in the White Mountains of New Hampshire were measured to estimate susceptibility to acid precipitation. All ponds experienced short-term acidification during snowmelt events. Historic pH and alkalinity data from these ponds are inadequate to determine if they are acidifying. Each pond is unique and to characterize them based on only one or two parameters is inadequate.

Cain, M. D.; Yaussy, D. A. **Can hardwoods be eradicated from pine sites?** Southern Journal of Applied Forestry. 8(1): 7-13; 1984.

Intensive mechanical and chemical treatments were used annually for 12 years to eradicate hardwoods from a selectively managed loblolly/shortleaf pine stand in south Arkansas. Although temporarily effective, a succession of indigenous shrubs and trees followed the cessation of eradication treatments. Improved pine diameter distribution from natural regeneration and an increase in radial growth of overstory pines were benefits of this temporary hardwood eradication.

Cannon, W. N., Jr. **Effects of adult density and temperature on development of *Scolytus multistriatus*.** In: Proceedings, 39th annual meeting of the North Central Branch, Entomological Society of America; 1984 March 26-29; Wichita, KS. College Park, MD: Entomological Society of America, North Central Branch; 1984. Abstract 94.

Through infestation, beetle densities of either 10 or 50 females per 100 cm³ of phloem were established on American elm bolts held at either 25°C or 30°C. After infestation, the elm bolt samples were randomly selected weekly for 6 weeks from each treatment to determine beetle development. At the low density, mean

development time varied inversely with temperature: 58 hours longer at 25°C than at 30°C. At the high density, mean development time was only 7 hours longer at 20°C than at 30°C. The shortest development time occurred at 30°C in low-density populations. The next longest time was for low-density populations at 25°C followed by the high-density populations at 30°C and the 25°C.

Cannon, William N., Jr.; Schroeder, Herbert W. **Visual impact of street trees in Ohio residential neighborhoods.** The Buckeye Arborist. 15(5): 7-9; 1984. Research on esthetics of urban landscapes has shown that vegetation is an important feature adding to the visual quality of urban environments. In a recent investigation, people who viewed 35-mm color slides of residential streets rated those showing large, older street trees higher than those showing smaller trees or no trees. Apparently, street trees are very important for the appearance of the street, but newly planted young trees need to grow some before they have a significant impact on esthetic quality.

Carey, A. C.; Miller, E. A.; Geballe, G. T.; Wargo, P. M.; Smith, W. H.; Siccama, T. G. **Armillaria mellea and spruce decline in northern forests.** Plant Disease. 68(9): 794-795; 1984.

Roots of 288 red spruce trees in mixed hardwood, transitional, and montane boreal forests in New England and New York were excavated and examined for colonization by *Armillaria mellea* (Vahl. ex Fr.) Kummer. The fungus was associated with declining and dead spruce at all geographic locations. The percentage of roots colonized by the fungus increased with increasing severity of decline symptoms but decreased with increasing elevation. In high-elevation montane boreal forests, where the decline has been documented to be most intense, 75 percent of the recently dead and severely declining trees were not colonized by *A. mellea*. Although *A. mellea* is involved in red spruce decline, it is not the major cause of the current regional episode of spruce decline and mortality.

Collins, Judith A.; Jennings, Daniel T. **A simplified holder for eumenid nesting blocks (Hymenoptera: Eumenidae).** Entomological News. 95: 58-62; 1984.

Considine, Thomas J., Jr. **An analysis of New York's timber resources.** Resour. Bull. NE-80. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 70 p.

A comprehensive analysis of the current status and trends of the forest resources of New York. Topics include forest area, timber volume biomass, timber products, timber growth and removals. Forest management opportunities for increasing the production of major forest resources and enhancing the benefits derived from New York forests are identified.

Crawford, H. S. **Silvicultural practice and bird predation on spruce budworm.** Forest Technique. 84(9): 12; 1984.

Crawford, Hewlette S. **Wildlife habitat management and changing forest practices in the Northeast.**

Northern Journal of Applied Forestry. 1(1): 12-14; 1984.

Increasingly intensive management of northeastern industrial forest lands will substantially affect wildlife habitat. Opportunities for increasing wildlife habitat values on the best forest sites may be impractical because high timber management costs preclude loss of products to favor wildlife. Wildlife habitat can be enhanced on low-quality timber sites, but inherent site productivity will limit gains. The most practical opportunity for increasing wildlife habitat values usually is on intermediate-quality sites. Increased habitat value can be accomplished by coordinating timber and wildlife habitat management goals. Gains in wildlife habitat value must be quantified to help offset losses in timber values.

Dyer, Jerry T. **Effect of minesoil compaction on growth and yield of KY-31 tall fescue and sericea lespedeza.** Res. Note NE-320. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 5 p.
Kentucky 31 tall fescue and sericea lespedeza were grown on clay loam minesoils that had been screened through a No. 10 sieve and compacted to densities of 1.6, 1.8, and 2.0 g/cm³. Stands of sericea lespedeza were more difficult to establish than fescue on both minesoils and were more susceptible than fescue to increased levels of compaction. Dry-matter yields averaged over all densities were greater on the clay loam than on the loam minesoil.

Dyer, Jerry T.; Dyer, Kenneth L. **Evaluation of Bentonite for the control of acid drainage from surface mined lands.** In: Surface mining and water quality: 10th annual West Virginia surface mine drainage task force symposium; 1984 March 21-22; Morgantown, WV. Charleston, WV: West Virginia Mining and Reclamation Association; 1984: 9 p.

Bentonite is a montmorillonitic clay known for its water sealing action. Bentonite when wet expands to form a mass of crystalline sheets largely impenetrable to water. Bentonite is evaluated by developing a bentonite/minesoil seal over a layer of toxic minewaste which was underlaid by PVC plastic lining. In addition to three control plots containing no bentonite, three plots contain 1 pound of bentonite per square foot and three plots contain 2 pounds of bentonite per square foot. The plots are approximately 16 x 16 feet. Drains above and below the bentonite layer are connected to 55-gallon barrels. Volume of runoff is measured in the barrels.

Usswa, C. T.; Barnard, J. E.; Gravatt, G. R.; DuBrock, J. W. **A preliminary assessment of forest wildlife habitat in Pennsylvania.** In: Proceedings, Renewable resources management applications of remote sensing; 1983 May 22-27; Seattle, WA. Falls Church, VA: American Society of Photogrammetry; 1984: 110-115.

This report is based on the integration of data from the Pennsylvania Game Commission's wildlife data base and the SDA Forest Service's Pennsylvania forest resource data base. The forest resource data base contains information from 1,000 permanent plots--79,373 points on recent aerial photos and 1,743 new plots as a sub-

sample of photo points. The wildlife data base contains information for 844 resident or common migrant animals in Pennsylvania. Data were analyzed to make a preliminary assessment of forest wildlife habitat in the Commonwealth.

Czapowskyj, M. M.; Safford, L. O. **Hybrid poplar response to fertilization and control of competition.**

Agronomy Abstracts. 1984: 258. Abstract.
Unrooted cuttings of clones NE-41 and 388 were planted on a clearcut, drum-chopped, hardwood site in eastern Maine. On half the area, competing vegetation was mowed annually for the first 3 years after planting. Plots were treated with lime, alone and combined with N, P, NP, and NPK. After 8 growing seasons, biomass and nutrient content of hybrid poplar were increased substantially by fertilization plus control of competing vegetation.

Dale, Martin E.; Sonderman, David L. **Effect of thinning on growth and potential quality of young white oak crop trees.** Res. Pap. NE-539. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 12 p.

Relative changes in several types of stem defects were studied over a 16-year period to determine the effect of thinning intensity on the development of tree quality. Sixty-six sample white oak crop trees represented each of five density levels created by thinning a young white oak stand in Kentucky in 1961. Occurrence of branch-related and other stem defects on the butt 16-foot section was studied from stereo pairs of photographs taken in 1961 and 1977. The number of live and dead branches greater than 0.3 inch in basal diameter increased on all density plots. Except for extremely heavy thinnings, those below C-level stocking, tree quality was not markedly affected by residual stand density.

Davidson, Walter H.; Hutnik, Russell J.; Parr, Delbert E. **Reforestation of mined land in the Northeastern and North-Central U.S.** Northern Journal of Applied Forestry. 1(1): 7-12; 1984.

Reviews the state of the art of surface mine reclamation for forestry in Pennsylvania, Maryland, West Virginia, Ohio, Indiana, and Illinois. Legislative constraints, socioeconomic issues, factors limiting the success of reforestation efforts, post-mining land-use trends, species options, and establishment techniques are discussed. Sources of assistance to landowners or managers are given and major publications on reclamation methods are cited.

Davis, Donald D.; Millen, Amy A.; Dochinger, Leon, eds. **Air pollution and the productivity of the forest.** Proceedings of the symposium; 1983 October 4-5; Washington, DC. Arlington, VA: Izaak Walton League of America; 1984. 344 p.

Reviews pertinent literature relating to effects of air pollution on forest productivity, and discusses current research directions in this area. Emphasis was directed toward effects of oxidants (primarily ozone) and acid rain on forest productivity.

DeBell, D. S.; Harms, W. R.; Marquis, D. A.; Curtis, R. O. **Trends in stand management practices for U.S. forests.** In: New forests for a changing world: Proceedings, 1983 convention of the Society of American Foresters; 1983 October 16-20; Portland, OR. SAF Publ. 84-03. Bethesda, MD: Society of American Foresters; 1984: 47-51.

Current stand management practices in mixed hardwood, southern pine, and Douglas-fir forests are described. Silvicultural activities attained greater importance in many forest management organizations during the past 10 to 15 years; growing-stock control and fertilizer application have become common practices in some forest types. In the future, prescriptions for stand management practices will become more site-specific and more concerned with both wood quality and nontimber resources.

DeGraaf, Richard M. **Urban wildlife and fisheries.** In: Wenger, Karl R., ed. *Forestry handbook*. New York, NY: John Wiley & Sons; 1984: 945-957.

The urban wildlife and fisheries section of the *Forestry Handbook* presents the effects of urbanization on wildlife, and provides information to improve urban wildlife habitat. Bird species are listed where populations are either significantly increased or decreased as a result of urbanization. Area-sensitive species and their requirements are listed. Trees are rated as to their wildlife food, nesting, or cover value; site requirements of valuable wildlife shrubs are provided, as well as information on retention of cavity or den trees, unmowed borders, understory development and reduction of forest fragmentation. Nest box dimensions and landscape plants are listed. Fish habitat management includes brief list of species tolerant of urban water conditions, weed control, and bank stabilization.

DeGraaf, Richard M.; Chadwick, Nan L. **Habitat classification: a comparison using avian species and guilds.** *Environmental Management*. 8(6): 511-518; 1984.

Results of breeding bird censuses in 1979 and 1980 were used to compare the relationships of species and guilds to forest habitats in the White Mountains of New Hampshire. Several age classes of 11 forest cover types were studied: northern hardwoods, spruce, spruce-fir, birch, swamp hardwoods, pine, balsam fir, aspen, northern red oak, oak-pine, and hemlock. Results of ordinations based on censuses of 74 bird species indicate that foraging guilds are more related to general cover types than nesting substrate guilds, but bird species reflect habitat differences to a greater degree than either guild scheme. Bird species distribution greatly overlaps between hardwoods and mixed forests; softwoods show little overlap with other types.

DeGraaf, Richard, M. **Managing New England woodlands for wildlife that uses tree cavities.** Amherst, MA: University of Massachusetts Cooperative Extension Service; 1984; Bulletin C-171. 16 p.

Cavity trees are used by one-fourth of terrestrial New England wildlife for shelter, caching food, escape from predators, and producing and rearing young. Good forestry includes marking such trees for retention before treatment or harvest is begun. This bulletin is a guide

to wildlife use of cavity trees, and provides woodland owners and managers with information to maintain habitats for these species.

Dempsey, Gilbert P.; Price, Karen S., eds. **Governor's conference on West Virginia's forest industry.**

Workshop proceedings; 1983 November 7-8; Charleston, WV. Charleston, WV: Governor's Office of Economic and Community Development and West Virginia Forests, Inc.; 1984. 208 p.

The goals of the 1983 Governor's conference on West Virginia's forest industry were to identify the issues and recommend policies, ways, and means for developing West Virginia's forest resources to: (1) secure economic contributions commensurate with its potential; and concurrently, promote the wise management and use of the forest resource to enhance other important values such as water, wildlife, recreation, and esthetics. An agenda for the forest community and public institutions has been developed.

Denig, Joseph; Wengert, Eugene M.; Brisbin, Robert; Schroeder, James. **Dimension lumber grade and yield estimates for yellow-poplar.** *Southern Journal of Applied Forestry*. 8(3): 123-126; 1984.

Equations that predict the dimension lumber grade yield from yellow-poplar trees and sawlogs that are manufactured into 2 x 4's using the Saw-Dry-Rip system are presented. These equations require the measurement of d.b.h. and merchantable height measured to an 8-inch top diameter. To predict the dimension lumber yield from yellow-poplar logs, a grading system that incorporates limiting defects with the clear-face concept used in southern pine log grading is utilized to stratify the logs. Once the logs have been graded, scaling diameter is used to predict the dimension lumber yield.

Dimond, J. B.; Mott, D. G.; Kemp, W. P.; Krall, J. L. **A field test of mating-suppression using the spruce budworm sex pheromone.** *Tech. Bull.* 113. Orono, ME: Maine Agricultural Experiment Station, University of Maine at Orono; 1984. 15 p.

Spruce budworm sex pheromone was dispersed from aircraft over forest land in Maine in late June, 1980. A major goal was to sample pheromone concentration in air, through chemical means, to determine whether the Hercon flake formulation would provide the steady, sustained release of chemical believed required for interfering with the mating process of the moths. It is believed that the opportunity of studying some behavioral effects on spruce budworm populations should be exploited also. This report describes these studies.

Dimond, John B.; Seymour, Robert S.; Mott, D. Gordon. **Planning insecticide application and timber harvesting in a spruce budworm epidemic.** *Agric. Handbook* 618. Washington, DC: U.S. Department of Agriculture, Forest Service, Cooperative State Research Service; 1984. 29 p.

Donley, David E.; Feicht, David L. **Relationship between dead oak value and associated wood borer.** In: Miller, A. R., ed. *National gypsy moth review Proceedings of a symposium*; 1984 November 26-28; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plant Pest Control Division; 1984: 103-105.

ture oaks killed by gypsy moth defoliation should be removed promptly to avoid loss of timber value to borer damage.

Inley, David E.; Feicht, David L. **Sawtimber losses associated with gypsy moth defoliation in central Pennsylvania.** In: Miller, A. R., ed. National gypsy moth review: Proceedings of a symposium; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plant Pest Control Division; 1984: 106-109.

Between 1978 and 1982, the "front" of defoliation by the gypsy moth swept over central Pennsylvania. In the 5-year period, defoliation of individual stands was neither complete nor continuous, but most of the study areas were defoliated at a level of over 50 percent for at least 2 years. In 1983, more than half the trees on some 6,000 acres died. Oak volume and value estimates were obtained from salvage sale data and a series of prism point samples collected in 1983 and 1984. Dead oak volume ranged from 3.5 to 11.0 M bf per acre. Values ranged from a low of \$281 an acre to a high of \$14. Dead oak trees averaged 246 board feet per tree. Timber buyers are biased against dead trees. This bias is justified because trees dead more than 2 years are riddled with galleries of the oak timberworm.

Inley, David E.; Rast, Everette. **Vertical distribution of the red oak borer, *Enaphalodes rufulus* (Coleoptera: Cerambycidae), in red oak.** Environmental Entomology. 13(1): 41-44; 1984.

Red oak borer attack height was directly related to red oak size in immature oak stands. Attack density was inversely related to tree size. Borer density within size classes did not differ significantly when trees from Pennsylvania stands were compared with trees from Virginia stands. Median attack height was always ≤ 5 m for trees up to 30.0 cm d.b.h. Almost 75 percent of the attacks were found in the economically important basal 4 m trunk portion in all size classes of trees.

Ibois, Normand R. ***Bacillus thuringiensis* NRD-12: Selection of a more potent strain of Bt for use against the gypsy moth.** In: Miller, A. R., ed. National gypsy moth review: Proceedings of a symposium; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plant Pest Control Division; 1984: 94-95.

Inglis, M. J.; Schoch, L. B.; Rowntree, R. **Can multi-channel remotely sensed spectral radiance data augment higher resolution aerial photography in urban studies?** In: Technical papers of the 50th annual meeting of the American Society of Photogrammetry; 1984 March 11-16; Washington, DC. Falls Church, VA: American Society of Photogrammetry; 1984: 157-163. Vol. 1.

Describes a modest experiment performed over the Syracuse, New York, area in which a combination of aerial photography, ground reflectance measurements, and simulation modeling was used to predict spectral signatures from Landsat pixel-sized areas in various urban and suburban regions of importance to urban natural resource management. By obtaining digital data from the Landsat multispectral scanner (MSS) over the same area during the same season, we showed that

the calculated and observed relative spectral signatures are sufficiently similar to suggest that information obtained by photointerpretation may be augmented, on a repetitive basis, by the spectral radiance information obtained from the MSS.

Dyer, Kenneth L. **Water, friend or foe in the control of acid mine drainage.** In: Surface mining and water quality: 5th annual West Virginia surface mine drainage task force symposium; 1984 March 21-22; Morgantown, WV. Charleston, WV: West Virginia Mining and Reclamation Association; 1984: 16 p. Water traditionally has been considered an enemy in the battle to halt the formation and transport of acid mine drainage; so, efforts and laws have been directed at keeping water away from toxic spoil materials. It is becoming increasingly clear that even the most stringent measures for keeping water from toxic spoils have not fully prevented formation and transport of acid mine drainage. There is ample evidence that immersing toxic spoils under water cannot only prevent the formation of acid mine drainage, but, under some circumstances, can remove it from solution.

Dyer, Kenneth L.; Curtis, Willie R.; Crews, Jerry T. **Response of vegetation to various mulches used in surface mine reclamation in Alabama and Kentucky—7-year case history.** Gen. Tech. Rep. NE-93. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 11 p.

Five different mulches and one mulch-amendment combination were evaluated in the reclamation of two different mine spoils, one in western Kentucky and one in northern Alabama. The treatments evaluated were bark, hardwood chips, straw, hay, hydromulch, and hydromulch plus Petroset SB emulsion. After 7 years, the effects of the different mulch treatments were readily apparent at the Alabama site where the hardwood-chip plot had strikingly superior cover. Differences were not so apparent at the Kentucky site.

Echelberger, H. E. **X-C monitor.** Ski Area Management. 23(3): 58; 1984.

Echelberger, Herbert E. **First report shows X-C business up.** Ski Area Management. 23(2): 22; 1984.

Echelberger, Herbert E. **Skier visits up.** Ski Area Management. 23(1): 28, 30; 1984.

Echelberger, Herbert. **Monitor's measure.** Ski Area Management. 23(1): 26-28, 30, 70, 73; 1984.

Eck, Ronald W.; Burks, Randall S.; Morgan, Perry J.; Phillips, Ross A. **Economic analysis of broad-based dips versus conventional drainage structures on forest roads—preliminary results.** In: Proceedings, Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 193-200.

Presents preliminary results of an on-going study conducted to address the issue of broad-based dips versus conventional drainage structures. A decisionmaking framework was developed that can be used as a general

guide to factors to consider in selecting a dip or culvert in a particular application. Specific questions that the engineer should address relative to soils/geology, hydrology, construction, maintenance and road-user factors were identified. The experimental design to be used to collect detailed data at a number of field sites in the Monongahela National Forest in West Virginia was outlined.

Eli, Robert N.; LeDoux, Chris B.; Peters, Penn A. **MAP — A Mapping and Analysis Program for harvest planning.** In: Proceedings, Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 48-63. The goal of this computer software package is to significantly improve the planning and harvest efficiency of small to moderately sized harvest units located in mountainous terrain. The intention is to develop an interactive user-friendly system to be implemented on the Hewlett-Packard 9845 computer system.

Emmons, Cheryld L.; Noble, Reginald D.; Jensen, Keith F. **Effects of simulated acid mist on *Liriodendron tulipifera*.** Plant Physiology. 75(1): 67; 1984. Abstract.

Emmons, Cheryld L.; Noble, Reginald D.; Jensen, Keith F. **Effects of simulated acid mist on *Liriodendron tulipifera*.** In: Proceedings, 93rd annual meeting, The Ohio Academy of Science; 1984 April 27-29; (Location of meeting unknown). The Ohio Journal of Science. 84(2): 1984. Abstract.

Yellow-poplar saplings were treated with acid mists created from solutions of sulfuric and hydrochloric acids at pH levels of 2.3, 3.0, and 4.5 for 6 hours a day for 2 weeks. Visible damage was apparent at pH levels of 2.3 and 3.0, and consisted of necrosis of marginal and intra-veinal tissues. The pH effects were apparent on diffusive resistance (pH 3.0 lowest, $p = 0.0658$), net photosynthetic rate (pH 3.0 lowest, $p = 0.0724$), and dark respiration rate (pH 3.0 greatest, $p = 0.0018$). Sulfuric acid treated trees showed significantly different responses at all pH levels from those treated with HCl in terms of ribulose 1,5-biphosphate carboxylase activity (H_2SO_4 lower than HCl, $p = 0.0390$). No significant effects of pH nor treatment were found for chlorophyll content, chlorophyll a:chlorophyll b ratio, or protein content, but in all treatments pH 3.0 caused either the highest or lowest levels of response and H_2SO_4 treatments caused lower levels of response than HCl treatments (except for protein content).

Federer, C. Anthony. **Organic matter and nitrogen content of the forest floor in even-aged northern hardwoods.** Canadian Journal of Forest Research. 14(6): 763-767; 1984.

Organic content of the forest floor decreases for several years after clearcutting, then slowly recovers. Thickness, bulk density, organic matter, and nitrogen were measured in forest floors of 13 northern hardwood stands in the White Mountains of New Hampshire. Stands ranged in age from 1 to about 100 years. Forest-floor thickness varied significantly with stand age, but bulk density, organic fraction, and nitrogen fraction were independent of age. Some of the initial decrease in organic matter and nitrogen content of the

forest floor may be caused by organic decomposition and nitrogen leaching, but mechanical and chemical mixing of floor into mineral soil during and after the harvest operation may be important.

Fege, Anne S.; Brown, Gregory N. **Carbohydrate distribution in dormant *Populus* shoots and hardwood cuttings.** Forest Science. 30(4): 999-1010; 1984. Stems from two hybrid *Populus* clones were collected from September to May to determine the effect of harvest date and sampling position on carbohydrate availability. Total sugars increased to a December maximum of 25 percent of dry weight in the shoot tip then declined through early spring. Maximum starch content of 7 percent was measured in clone 5262 in early October and 12 percent in clone 5334 in early September. Total carbohydrates ranged from 4.3 to 27.2 percent of dry weight, with significantly lower levels in September and May. Concentrations of sugar and starch were significantly greater at upper shoot positions.

Fernandez, I. J.; Czapowskyj, M. **Forest floor heavy metal levels in low elevation commercial forests of Maine.** Agronomy Abstracts: 258; 1984.

Concern in the Eastern United States for the effects of long-range transported air pollutants has focused on the possible role of acid precipitation, ozone, or heavy metals in forest growth. Several studies have shown evidence of heavy metal accumulations in the surface organic horizons of northeastern forest soils.

Fisher, Edward L.; Goehenour, Donald L.; Biller, Cleveland J. **Significant factors affecting performance of the Urus Cable yarder.** Transactions of the ASAE. 27(4): 962-967; 1984.

The Urus Cable yarder, rigged as a multispan skyline system, yarded tree length hardwood logs uphill 430 feet at a cost of \$72 per thousand board feet. The silvicultural prescription was a diameter limit, partial cut that removed 5,770 board feet per acre. Regression analysis yielded the following equation for cycle time: cycle time, min = $2.95 + 0.0045$ (slope yarding distance in feet) + 0.02404 (lateral yarding distance in feet); $R^2 = 0.46$, SE = 1.93 min.

Frank, Robert M. **Shelterwood system of silviculture in spruce-fir forests.** Forest Technique. 84(8): 9; 1984.

Describes the shelterwood sequence: a mature forest in which seedlings are absent or not well established is partially harvested; seedlings are well established 5 to 10 years after first partial harvest; about 5 years after final harvest of shelter trees, new trees are ready for initial thinning.

Fridley, J. L.; Garbini, J. L.; Jorgensen, J. E.; Peters, P. A. **Functional requirements and design parameters of swing-to-bunch feller-bunchers for forest thinning.** In: Proceedings, Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 363-372.

Interactive simulation is used to obtain data relating design parameters to functional requirements of swing-to-bunch feller-bunchers. Design parameters include

ch ratio, operating rates, boom/machine weight
ratio, and boom support locations. Functional require-
ments include thinning selectivity, productivity, tipover
stability, bunching capability, structural integrity, and
boom-tip control.

Gariel, William J.; Garrett, Peter W. **Pollen vectors in
sugar maple (*Acer saccharum*)**. Canadian Journal of
Botany. 62(12): 2889-2895; 1984.

To determine whether insect vectors alone are responsi-
ble for all of the pollination that occurs in sugar
maple, pistillate flowers of three trees in Vermont were
covered with fine mesh bags. This procedure provided
evidence that this species can receive sufficient pollen
for pollination by wind alone, though both insects and
wind are factors in pollen distribution under optimal
weather conditions.

Gordon, Jimmy R. **Selection for a nondiapausing strain
of artificially reared red oak borers**. Res. Note
NE-319. Broomall, PA: U.S. Department of Agricul-
ture, Forest Service, Northeastern Forest Experi-
ment Station; 1984. 4 p.

The incidence of nondiapause in artificially reared red
oak borers increased from 4 to 61 percent in five gener-
ations. Fecundity dropped by more than 50 percent, but
fertility was unaffected. Sixty percent of the nondia-
pausing larvae formed prepupa by the 12th week of
development in the F₁ and in the F₄ generations.

Gordon, Jimmy R. **The locust borer**. For. Insect & Dis.
Leaflet 71. Washington, DC: U.S. Department of
Agriculture; 1984. 6 p.

The locust borer attacks the black locust, a popular
shade tree. This tree is used extensively in reforesta-
tion and land-reclamation plantings. Native to North
America, the locust borer is found from Eastern
Canada, south to the Gulf States and west to Washing-
ton, Colorado, and Arizona. Only black locust and its
cuivars are attacked.

Gosner, Dave; Casey, Lloyd. **Value growth rates**. The
American Tree Farmer. 3(1): 10-11; 1984.

Presents an easy method for estimating the current
rate of value growth for trees and timber stands. Wise
woodland owners keep close tabs on the financial earn-
ing of their timber. All they need is a diameter tape,
an increment borer, and the table shown in this paper.

Gosner, David A. **Predicting forest stand losses to
gypsy moth**. In: Minutes 28th Southern forest in-
sect work conference; 1983 August 8-11; Biloxi, MS.
Baton Rouge, LA: Louisiana State University; 1984:
26.

Gosner, David A.; Herrick, Owen W. **Guides for estim-
ating forest stand losses to gypsy moth**. Northern
Journal of Applied Forestry. 1(2): 21-23; 1984.

People who have to make decisions about cost-effective
management for gypsy moth need help in predicting and
evaluating its effects. Field plot data collected during
recent outbreaks in Pennsylvania are being used to
develop guides for predicting forest stand losses to the
pest. Presented here are some of the more useful
products of that effort to date. Easy-to-measure data
on forest characteristics such as species composition

and crown condition can be collected and applied in
models that estimate potential stand and tree mortality
and changes in timber value.

Gansner, David A.; Herrick, Owen W. **Guides for estim-
ating forest stand losses to gypsy moth**. The
Allegheny News. Summer 1984: 11-13.

Garrett, Peter W.; Funk, David T.; Hawley, Gary J.;
Wendel, G. W. **Heritability of response to wounding
in sugar maple (*Acer saccharum* Marsh.)** In:
Lanner, R. M., ed. 8th North American forest biol-
ogy workshop: Proceedings of a symposium; 1984
July 30 - August 1; Logan, UT. Logan, UT: Utah
State University; 1984: 168. Abstract.

A combined provenance/progeny test of sugar maple
was established on the Fernow Experimental Forest.
Three-year-old seedlings were planted on a clearcut
mixed-hardwood site; 112 open-pollinated families, 8
from each of 14 provenances, were planted at random
in two-tree plots in each of five blocks. After 14 years,
the plantation was fully stocked. In plots with two
surviving trees, the smaller or poorer formed individual
was marked for thinning. Marked trees were wounded
by drilling a 1.0-cm hole, 2.5 cm deep at breast height.
The marked trees were harvested 7 months later, and a
30-cm sample of the bole removed for analysis. There
was no significant variation in response to wounding
related to geographic origin, though the 14 provenances
were well distributed over the northern part of the
natural range of sugar maple.

Gatchell, Charles J. **Make money with small-diameter
logs and No. 2 Common lumber**. Southern Lumber-
man. 245(3048): 21-23; 1984.

Describes new approaches to the use of small-diameter
logs and No. 2 Common lumber for furniture and cabin-
ets. Complete, new manufacturing schemes require
standard-size blanks as a new intermediate product.
Sizes for these blanks are based on the actual needs of
manufacturers. Log-run lumber can be made to blanks
in a conventional, crosscut-first rough mill. The con-
version of small-diameter logs (7-1/2 to 12-1/2 inches)
to blanks requires a new approach: System 6. The use
of gang saws to break down cants and crosscut and rip
System 6 boards is essential for removing 80 percent or
more of the defects before operators make cut-to-
length decisions. For minor changes in a conventional
rough mill, the potential for using No. 2 Common lum-
ber by gang-ripping first and a method for making long
pieces from short with Serpentine end matching are
discussed.

Gatchell, Charles J. **Make money with small-diameter
logs and No. 2 Common lumber**. Furniture Produc-
tion. 47(390): 27-29; 1984. See previous entry.

Godwin, Paul A. **Two bees or not two bees**. Citizens'
Bulletin. 12(2): 9, 19-20; 1984.

A brief, nontechnical discussion of insect mimicry with
several examples found among Connecticut insects.
The well-known Monarch butterfly and its mimic
Viceroy butterfly are cited. Also described are less
well-known examples that have greater consequences
for humans. These are flies disguised as bees and
wasps.

Godwin, Paul A. **On "katydid" and other onomatopoeia.** Citizens' Bulletin. 12(3): 14-15; 1984.

Gottschalk, Kurt W. **Effects of temperature on germination of northern red and black oak acorns.** In: R. M. Lanner, ed. 8th North American forest biology workshop: Proceedings of a symposium; 1984 July 30 - August 1; Logan, UT. Logan, UT: Utah State University; 1984: 149. Abstract.

Constant and alternating temperatures ranging from 0° C to 30° C were tested for their effects on germination of northern red and black oak acorns. No significant differences in total germination were found between the temperature treatments; however, the time to initial germination was shorter and the duration of germination was shorter for warmer temperatures.

Gottschalk, Kurt W. **Modifying silvicultural decisions to deal with the gypsy moth: A decision tree approach.** In: Changing markets - Changing forestry, Abstracts of proceedings, 64th annual winter meeting, New England Society of American Foresters; 1984 March 7-9; Worcester, MA. SAF Publ. #84-04. Bethesda, MD: Society of American Foresters; 1984: 11.

Describes a decision tree that enables foresters and land managers to modify silvicultural decisions to minimize the impacts of tree mortality due to gypsy moth defoliation. Potential silvicultural treatments are discussed. The decision tree is based on imminence of defoliation, relative stand density, percentage of basal area in preferred food species, advance regeneration stocking, and stand-size susceptibility-vulnerability ratings.

Gottschalk, Kurt W. **Research on silvicultural options for the gypsy moth.** In: Miller, A. R., ed. National gypsy moth review: Proceedings of a symposium; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture, Plant Pest Control Division; 1984: 96-98.

Grace, Linda S.; Biller, Cleveland J.; Means, Kenneth H. **A survey of tractor stability analysis.** In: Proceedings, 1983 winter meeting American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. Pap. No. 83-1618. St. Joseph, MI: American Society of Agricultural Engineers; 1983. 21 p.

A comprehensive literature review was made of tractor stability analysis. The review includes work done on articulated tractors. The bibliography includes 128 references.

Gregory, G. F.; Schreiber, L. R.; Ichada, J. **Microorganisms antagonistic to or producing antibiotic inhibitory to *Ceratocystis ulmi*.** Phytopathology. 74(7): 804-805; 1984. Abstract.

Studies were conducted to identify organisms antagonistic to the Dutch elm disease fungus. The colonizing ability of candidates was determined by introducing them into the vascular system of American elm seedlings and then isolating periodically from leaf petioles. *Trichoderma* and *Bacillus* spp. are the most promising. *B. subtilis* and *B. coagulans* were isolated from the xylem of elms inoculated with the pathogen. When

mixtures of *B. subtilis* and *C. ulmi* spores, impregnated into blank bioassay discs, were placed on PDA, bacterial growth was dominant even when the bacterium was a very low proportion of the mixture.

Gregory, Robert A.; Wong, Betty L.; Tabor, Christopher A. **Characterization of vernal sap from shoots of five tree species.** Plant Physiology. 75(1): 150; 1984. Abstract.

Extracted sap from shoots containing 1- and 2-year-old secondary xylem of *Acer*, *Betula*, *Populus*, *Abies*, and *Picea* was analyzed to determine the content of the sap during vernal activity. Two to three shoots were collected from the lower crown of each tree at weekly intervals from March 2 through June 1, 1983. Sap extracted from each species on a given date was pooled and stored at -20°C prior to analyses. Mean values for the concentration of inorganic and organic sap solutes and for sap pH were determined throughout the period and referenced to phenological events. The relatively high concentration of sap solutes, presumably mobilized from storage tissues, varied according to vernal activities such as bud opening. Although sap pH differed considerably between species, all showed a steady decline from late winter (pH 7-8) to late spring (pH 5-7).

Grimble, David G.; Kucera, Daniel R., co-chairmen. **Proceedings, new and improved techniques for monitoring and evaluating spruce budworm populations;** 1983 September 13-15; Burlington, VT. Gen. Tech. Rep. NE-88. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 71 p.

Presents new or improved methods available for monitoring and evaluating spruce budworm populations.

Halverson, Howard G.; DeWalle, David R.; Sharpe, William E. **Contribution of precipitation to quality of urban storm runoff.** Water Resources Bulletin. 20(6): 859-864; 1984.

Precipitation and runoff samples were collected for 13 storms in a nonindustrial urban area in central Pennsylvania between July 1980 and June 1981. Analysis of the water samples showed that 10 to 25 percent of the nitrogen, 25 percent of the sulfate, and less than 5 percent of the phosphorus, potassium, and calcium in water below a tree were deposited by the precipitation. The sample from a residential roof showed insignificant changes in water chemistry. The results for four paved areas showed that all the nitrogen; and from 16 to 40 percent of the sulfate; and 13, 4, and 2 percent of the phosphorus, potassium, and calcium, respectively, in runoff was deposited by the precipitation.

Hansen, Bruce G.; Reynolds, Hugh W. **System 6 alternatives: an economic analysis.** Res. Pap. NE-551. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 14 p.

Three System 6 mill-size alternatives were designed and evaluated to determine overall economic potential for producing standard-size hardwood blanks. Internal rates of return ranged from about 15 to 35 percent after taxes. Cost per square foot of blanks ranged from about \$0.88 to \$1.19, depending on mill size and the amount of new investment required.

Jensen, G. D. **A computer simulation model of uneven-aged northern hardwood stands maintained under the selection system.** Syracuse, NY: State University of New York College of Environmental Science and Forestry; 1984; Misc. Publ. No. 3 (ESF 84-017). 21 p.

A computer simulation model representing the growth of uneven-aged northern hardwood stands was developed to study the effects of different diameter distributions on stand productivity. A model user can specify initial distributions in terms of total stand basal area, minimum tree size, and a Q ratio. The model projects model stand growth over one cutting cycle and provides a summary of several growth measures. This paper outlines the general features of the model and describes the subroutines representing mortality, survivor growth, and ingrowth. Model limitations are also discussed.

Harris, Margaret M.; Sparring, Ann M., eds. **Research in forest productivity, use, and pest control;** Proceedings of a symposium; 1983 September 16-17; Burlington, VT. Gen. Tech. Rep. NE-90. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 95 p.

Proceedings of a symposium sponsored by the Civil Rights Action Committee of the Northeastern Forest Experiment Station and the University of Vermont School of Natural Resources to provide a forum for the presentation of current research in natural resource fields by women scientists.

Harris, Margaret; Fege, Anne S. **Women scientists: Contributions and connections.** Women in Forestry. 6(1): 15-16; 1984.

An account of the symposium "Research in forest productivity, use, and pest control" held in Burlington, Vermont, September 16-17, 1983, in which almost 100 researchers from universities, state and Federal agencies, and the private sector participated.

Heisler, Gordon M. **Planting design for wind control.** In: McPherson, E. Gregory, ed. Energy-conserving site design. Washington, DC: American Society of Landscape Architects; 1984: 165-183.

Briefly discusses heat transfer processes in buildings and basic mechanisms of windbreak effects on windflow and air temperature. A brief discussion of methods of economic evaluation of windbreak energy savings and the other benefits lead naturally to recommendations for design of windbreaks, including evaluation of wind climatology, tree density and spacing, space requirements, and species selection. Two design examples are illustrated.

Heisler, Gordon M.; DeWalle, David R. **Plantings that save energy.** American Forests. 90(9): 13-16; 1984.

Trees in proper locations around houses can save 20 percent and more, sometimes much more, of the energy required for air conditioning in conventional homes. Windbreaks may also yield large savings, typically 10 to 15 percent but sometimes more, of total heating energy used in houses that are otherwise exposed to high winds. Trees can waste energy if they shade substantially more in winter than they do in summer. This can be avoided and savings throughout the year maximized by carefully

selecting species and locations for trees, shrubs, and vines around houses.

Heisler, Gordon M.; DeWalle, David R. **Technical update: Tree management for energy savings.** The National Urban and Community Forestry Forum. 4(4): 5-6; 1984.

Helvey, J. D. **Reply to Discussion -"Sampling accuracy of pit vs. standard rain gages on the Fernow Experimental Forest," by John A. Kay.** Water Resources Bulletin. 20(2):277-278; 1984.

Herrick, Owen W. **Rate of value change in Pennsylvania timber stands.** Res. Pap. NE-547. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 5 p.

Data from remeasured Pennsylvania forest inventory plots revealed that during a 13-year period the compound rate of value change in uncut hardwood forest stands was 4.7 percent, and ranged from -5.5 to 18.8 percent. No well-defined means for predicting a stand's rate of value change could be identified. However, some measures of initial stand condition can be used to get a general indication of what to expect in stands with management potential. For example, stands with the highest rates of value change (averaging 7.5 percent) have (1) trees of average basal area less than 5 inches in diameter; (2) less than 10 percent of their basal area in large sawtimber-size trees; and (3) some yellow-poplar, northern red oak, and/or black oak.

Hertel, Gerard D. **Gypsy moth research program, Northeastern Forest Experiment Station.** In: Miller, A. R., ed. National gypsy moth review: Proceedings of a symposium; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plant Pest Control Division; 1984: 83-88.

With a substantial increase in funding for gypsy moth research, the Northeastern Forest Experiment Station began a new and exciting research initiative this year. The goal of this initiative is to obtain the knowledge necessary to manage gypsy moth populations so that outbreaks of the pest occur less frequently or are prevented.

Hornbeck, James W.; Corbett, Edward S.; Duffy, Paul D.; Lynch, James E. **Forest hydrology and watershed management.** In: Wenger, Karl F., ed. Forestry Handbook. New York, NY: John Wiley & Sons; 1984. 1335 p.

This chapter is for the field forester. The first half discusses the hydrologic cycle as applied to forest lands; the second half centers on water quality. Methods are given for sampling water quality and components of the hydrologic cycle. Impacts of forest utilization and disturbance on water yield and water quality are summarized.

Horsley, S. B.; Gottschalk, K. W. **Photosynthesis in developing leaves of black cherry (*Prunus serotina*) seedlings.** In: Proceedings, 8th North American forest biology workshop; 1984 July 30-August 1; Logan, UT. Logan, UT: Utah State University; 1984: 170-171. Abstract.

We determined net photosynthetic (Pn) activity of leaves at different ontogenetic stages of development on plants ranging in age from 7 to 20 plastochrons.

Horsley, Stephen B. **Ferns: Shapers of tomorrow's northern hardwood forests?** *Adirondac*. 1984 October/November: 20-24.

Houseweart, Mark W.; Jennings, Daniel T.; Lawrence, Robert K. **Field releases of *Trichogramma minutum* (Hymenoptera: Trichogrammatidae) for suppression of epidemic spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae), egg populations in Maine.** *The Canadian Entomologist*. 116(10): 1357-1366; 1984.

Trichogramma minutum Riley was released to suppress epidemic spruce budworm egg populations in Maine from 1977 to 1981. The California strain of *T. minutum* was released from the ground in 1977. In 1978, we found that the native Maine strain performed better than the California strain. In 1979, broadcast and multiple releases from the ground gave slight improvement. In 1981, three closely timed, aerial releases from the ground gave slight improvement. In 1981, three closely timed, aerial releases yielded parasitism rates significantly higher than those in control plots, but not sufficient to suppress epidemic spruce budworm populations.

Houston, David R. **What is happening to the American beech?** *The Conservationist*. 38(6): 22-25; 1984. Beech bark disease is a complex problem that begins when beech bark is attacked by the beech scale, and ends when infested bark is invaded and killed by fungi of the genus *Nectria*. In 1934, 44 years after it was accidentally brought to Nova Scotia, the scale was discovered in Nassau and Westchester Counties near New York City. In the 1940's, the disease agents and resultant tree mortality appeared in the Catskills. Moving northward from there, and westward from Vermont and Massachusetts, the disease reached the eastern Adirondacks in the 1950's. Today, heavy losses are occurring in many forests of the Adirondack Preserve and in some mid-state counties. The scale is now well entrenched throughout the state. Research is being conducted to determine how to reduce the losses caused by the disease.

Houston, David R. **Stress related to diseases.** *Arboricultural Journal*. 8(2): 137-149; 1984. Diebacks and declines are diseases triggered by the predisposing effects of biotic or abiotic stress factors and culminated by the attack of organisms of secondary action. In the forest, the primary stress factors are insect defoliation and extremes of moisture and heat. Of the many stresses in urban situations, drought is probably the most important. Organisms of secondary action are facultative parasites and are common inhabitants of natural habitats. Control of dieback and decline diseases usually requires preventing or reducing the effects of the stress agents rather than controlling the secondary-action organisms that cause mortality.

Hoyle, Merrill C. **Plantation birch: What works, what doesn't.** *Journal of Forestry*. 82(1): 46-49; 1984. In a 10-year pilot test of plantation management in the White Mountains of New Hampshire, fertilization and

brush control caused small or no increases in height or diameter growth of yellow birch; mortality was 50 percent and a high proportion of the stems was of poor quality. In contrast, paper birch showed increases of 1 percent in height over the control and 75 percent in diameter growth. As a result, basal-area growth of paper birch increased by 282 percent. Paper birch mortality was 10 percent, and all stems were of high quality. Estimates are that paper birch could average 52 feet in height and 13 inches in diameter at 30 years. The conclusion is that paper birch is well suited to intensive plantation management and that yellow birch is not.

Huyler, Neil K. **Test results of the Vermont cable yarder.** In: *Vermont cable yarder project: a co-operative demonstration*. Montpelier, VT: Vermont Department of Forests, Parks and Recreation; 1984: 18-31.

Reports the study results of a cost and productivity analysis conducted for the Vermont Cable Yarding System. The results are based on detailed time studies of the operation on four sites and overall operating time and cost records provided by the contractor. The research objectives of the study were to evaluate the production capabilities and cost of production under varied stand and site conditions, and to evaluate residual stand age.

Huyler, Neil K.; Koten, D. E.; Quadro, A. P. **Productivity and cost of three small fuelwood skidders.** *Journal of Forestry*. 82(11): 671-674; 1984.

Three small tractors--a Holder A-60, Pasquali 993, and Forest Ant--were tested for suitability in skidding fuelwood from a thinning in mixed northern hardwoods. At a 400-foot skidding distance, the Holder ranked the highest in production at 1.67 cords per scheduled hour; skidding cost averaged \$12.67 per cord. Values for the Forest Ant were 0.868 cord per scheduled hour at \$12.86 per cord; for the Pasquali they were 0.69 cord at \$18.12 per cord.

Jennings, D. T.; Frank, R. M.; Houseweart, M. W. **Attraction of male spruce budworm moths, *Choristoneura fumiferana* (Clemens), to pheromone-baited traps in small-tree thinnings.** *Journal of Chemical Ecology*. 10(10): 125-133; 1984.

Mean catches of spruce budworm moths were not significantly different among four small-tree thinning treatments of young spruce-fir hemlock regeneration. Significant inverse relationships were found between trap catches and distances to nearby spruce-fir hemlock overstory. Prevailing wind directions indicated that moths were attracted anemotactically to upwind pheromone sources. No definite trends were detected between catches and temperature or precipitation.

Jennings, Daniel T. **Automated counter for detecting and counting egg masses of the spruce budworm.** In: *Spruce-fir management and spruce budworm: Region 6 technical conference of SAF*; 1984 April 24-26; Burlington, VT. Bethesda, MD: Society of American Foresters; 1984: 143-145. Abstract. An optical-electronic counter (Prototypes I and II) was designed and developed for detecting and counting egg masses of the spruce budworm and the western spruce

form. The counter scans foliage samples, detects the presence of egg masses based on their characteristic fluorescing properties, and counts the egg masses electronically.

ings, Daniel T. **Automated egg mass counter.** In: Proceedings, new and improved techniques for monitoring and evaluating spruce budworm populations; 1983 September 13-15; Burlington, VT. Gen. Tech. Rep. NE-88. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984: 35.

Reviews the design and development of an automated egg mass counter. The counter scans foliage samples, detects egg masses based on their characteristic fluorescence, and counts the egg masses electronically.

ings, Daniel T.; Fellin, David G.; Batzer, Harold O.; Houseweart, Mark W.; Beckwith, Roy C. **Techniques for measuring early-larval dispersal of spruce and jack pine budworms.** Agric. Handb. 614. Washington, DC: U.S. Department of Agriculture, Forest Service; 1984. 33 p.

Early-instar larvae of the spruce budworm, the western spruce budworm, and the jack pine budworm disperse periodically within and from their host trees. Some larvae disperse by crawling, but most dispersal occurs when the small larvae "spin down" from trees on silken threads. The larvae spin silk from glands located near the mouthparts. The silk threads are anchored to branches or other attachment sites, and the larvae continue to spin silk as they descend from the tree. Frequently, the threads break at the point of attachment, and larvae are carried by winds, sometimes for great distances.

ings, Daniel T.; Houseweart, Mark W. **Predation by eumenid wasps (Hymenoptera: Eumenidae) on spruce budworm (Lepidoptera: Tortricidae) and other Lepidopterous larvae in spruce-fir forests of Maine.** Annals of the Entomological Society of America. 77(1): 39-45; 1984.

of species of eumenids, *Ancistrocerus adiabatus* (Saussure), *A. antilope* (Panzer), *A. catskill* (Saussure), and *Euodynerus leucomelas* (Saussure), accepted and provisioned trap-nesting blocks placed in a spruce-fir forest of Maine. The wasps preferred open habitats with abundant floral forage to dense spruce-fir stands. Two species, *A. catskill* and *E. leucomelas*, preyed on 1st instars of *Choristoneura fumiferana* (Clemens) and on other lepidopterous defoliators of northeastern hardwoods and softwoods. Spruce budworm comprised 3 to 8 percent of the total observed prey in strip clearcuts. The wasp associates included parasites of provisioned prey larvae and both parasites and predators of eumenids.

ings, Daniel T.; Houseweart, Mark W.;

Okendolpher, James C. **Phalangids (Arachnida: Opiliones) associated with strip clearcut and dense spruce-fir forests of Maine.** Environmental Entomology. 13: 1306-1311; 1984.

iv genera and at least seven species of phalangids were collected by pitfall traps in a spruce budworm-infested forest in northern Maine. More than 90 percent of the specimens were *Leiobunum calcar* (Wood). Significantly more individuals and species were trapped

in uncut residual strips and in dense spruce-fir stands than in clearcut strips. Peaks in seasonal activity for individuals and species coincided with spruce budworm egg and early larval stages. Species diversity indices were low; individuals were distributed unevenly among the forest conditions investigated. However, coefficients of community and percentage similarity generally were >80 percent for strip clearcuts and dense stands. Greater disparities were noted among uncut residual and clearcut strips. Neither age of strip clearcut (1 to 6 years) nor depth of litter had much influence on mean catches and mean numbers of species of phalangids per trap per week.

Jensen, K. F.; Noble, R. D. **Impact of ozone and sulfur dioxide on net photosynthesis of hybrid poplar cuttings.** Canadian Journal of Forest Research. 14(3): 385-388; 1984.

Softwood cuttings of hybrid poplar clone No. 207 were fumigated with either charcoal-filtered air (control), 0.5 ppm SO₂, or 0.5 ppm SO₂ + 0.25 ppm O₃ for 12 hours each day for 3 weeks. The net photosynthetic rate and CO₂ compensation point were then measured in a closed-loop gas assimilation system with an infrared gas analyzer. Net photosynthesis was measured at light intensities of 430 and 730 $\mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ (photosynthetically active radiation) and in CO₂ concentrations of 300, 500, and 1,000 ppm. Net photosynthesis increased with an increase in light intensity and CO₂ concentration but was significantly reduced by the SO₂ + O₃ treatment. The leaves were classified into five groups on the basis of visible injury. There were no significant differences in the net photosynthetic rates among uninjured leaves in the three fumigation treatments. However, analysis of the data from the SO₂ + O₃ treatment, which separated the leaves into injury classes, showed that the CO₂-injury class interaction was significant. At 300 ppm CO₂, there were no significant differences in the net photosynthetic rates among the five injury classes. At 500 and 1,000 ppm CO₂, there were significant differences in the photosynthetic rates between leaves without visible injury and those with injury. Photosynthesis in the injured leaves may have been suppressed by an increase in the respiration rate and a decrease in the photosynthetic area. The increased respiration rate is suggested by the CO₂ compensation point data that were significantly higher in all of the fumigated leaves. There were no significant differences in the chlorophyll content of the leaves from the three treatment groups.

Jensen, K. F.; Yaussy, D. **Growth analysis of yellow-poplar seedlings calculated by two growth functions.** In: Proceedings, 8th North American forest biology workshop; 1984 July 30 - August 1; Logan, UT. Logan, UT: Utah State University; 1984: 178. Abstract.

The growth of 1-year-old yellow-poplar seedlings was used to compare growth analysis variables calculated by the third order polynomial. In May, 250 seedlings were potted in 15-cm pots and placed on benches in a greenhouse. At budbreak and each week for 22 weeks thereafter, 10 randomly selected seedlings were harvested. Leaf area, leaf weight, and new stem weight for each seedling were measured. After transforming the data to natural logs, a third order polynomial and Gompertz

function were calculated for leaf area expansion and new growth weight increase over time. Relative growth rates (RGR), leaf area ratio (LAR), and net assimilation rate (NAR) were then calculated from each function.

Jensen, Keith F. **Interaction of humidity and atmospheric pollutants on stomatal resistance of *Liriodendron tulipifera* seedlings.** *American Journal of Botany*. 71(5) Part 2: 124; 1984.

Stomatal resistance usually decreases with an increase in humidity but may increase or decrease in the presence of atmospheric pollutants depending on the pollutant dose. To determine the impact of humidity and atmospheric pollutants on the stomatal resistance of *Liriodendron tulipifera* seedlings, 1-year-old seedlings were fumigated with either 0.15 ppm ozone, 0.25 ppm SO₂ or both for 5 hours a day for 5 consecutive days at either 40 or 80 percent relative humidity. Stomatal resistance was measured each day 1 hour before fumigation started, at the beginning of the fumigation period, after 2 and 5 hours of fumigation, and 2 hours after the end of the fumigation. At low humidity the daily cycle in the stomatal resistance of the control seedlings followed the same general pattern. Stomatal resistance of the fumigated seedlings in the high humidity fluctuated over a wider range with an increase in length of fumigation. It is probable that the higher humidity caused the stomata to open so pollutants could enter the leaves and modify the stomatal mechanism.

Kennedy, Bruce H. **Effect of multilure and its components on parasites of *Scolytus multistriatus* (Coleoptera: Scolytidae).** *Journal of Chemical Ecology*. 10(2): 373-385; 1984.

Several hymenopterous parasites of *Scolytus multistriatus* are attracted to components of its aggregation pheromone, multilure. *Cheilopachus colon*, *Entedon leucogramma*, *Dendrosoter protuberans*, *Spathius benefactor*, and *Cerocephala eccoptogastri* are attracted in various degrees to multilure, its components (multistriatin, 4-methyl-3-heptanol, and cubebene), and component combinations. *C. colon* was trapped in greatest numbers, yet was usually less numerous than *E. leucogramma* and *D. protuberans* in the study area. Impact of traps on *C. colon* may conceivably be reduced by multistriatin content in baits and/or by withholding traps until *S. multistriatus* flight begins.

Kingsley, Neal P. **A profile of the Pennsylvania forestland owner or beware of meadowlarks.** *Pennsylvania Forests*. 74(3): 10-11; 1984.

Kingsley, Neal P.; Dale, Martin E. **Thirty years at Vinton Furnace Experimental Forest. Part I.** *Ohio Woodlands*. 22(2): 10, 13, 26, 32, 34-35; 1984.

The Vinton Furnace Experimental Forest, established in 1952, has been the site of a number of significant forestry research studies and findings. This is the story of "the Vinton," its background, establishment, and research.

Kochenderfer, J. N.; Helvey, J. D. **Soil losses from a "minimum-standard" truck road constructed in the Appalachians.** In: *Proceedings, Mountain logging symposium*; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 215-225.

Soil losses from 11 road sections in the central Appalachians were measured. Nine of the sections were located on a newly constructed "minimum-standard" truck road, and two were on a graveled higher standard road. Average annual soil losses on the "minimum-standard" truck road ranged from 44 tons per acre for ungraveled road sections to 5 tons per acre for sections surfaced with 3-inch clean limestone gravel. Soil losses on the graveled sections of the "minimum-standard" road were similar to those measured on the higher standard road.

Kochenderfer, J. N.; Wendel, G. W.; Smith, H. Clay. **Cost of and soil loss on "minimum-standard" forest truck roads constructed in the central Appalachians.** Res. Pap. NE-544. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 8 p.

A "minimum-standard" forest truck road that provides efficient and environmentally acceptable access for several forest activities is described. Cost data are presented for eight of these roads constructed in the central Appalachians. The average cost per mile excluding gravel was \$8,119. The range was \$5,048 to \$14,424. Soil loss was measured from several sections of a minimum-standard road. Traffic was regulated the first year and unrestricted the second year. Losses ranged from 44 tons per acre on ungraveled road sections to 5 tons per acre on graveled sections. Soil loss from the graveled sections on the minimum-standard road was about the same as that from higher standard graveled roads.

Kostichka, Charles J.; Cannon, William N., Jr. **Costs of Dutch elm disease management in Wisconsin communities.** *Journal of Arboriculture*. 10(9): 250-254; 1984.

In 1980, communities participating in the Wisconsin Dutch Elm Disease Demonstration Program spent about \$2.62 per capita for Dutch elm disease management. The percentage of the total program expenditure for each control practice was: tree removal and disposal, 79 percent; systemic fungicide injections, 11 percent; sanitation and symptom surveys, 7 percent; and root-graft barriers, 3 percent.

Koten, Donald E.; Peters, Penn A.; Hubner, Steven A. **HARDAT a universal harvesting data storage and retrieval system.** In: *Proceedings, Mountain logging symposium*; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 65-78.

HARDAT is a computerized information storage, retrieval, and analysis system developed to provide a standardized harvesting data base for use in research and equipment evaluation. Each individual record of the data base describes a timber harvesting system and operational performance data on a specific harvesting unit. Each record follows a classification system which includes variables describing the harvesting system, the characteristics of the timber stand and harvest site, the products produced, the production levels achieved, the equipment employed, and the supplemental data identified. Analysis of the records on file in the data base

Summary output are achieved through the Statistical Analysis System (SAS).

Smith, Neil I.; Rosier, Robert L. **Wires for long-term identification of trees.** *Journal of Forestry*. 82(2): 10-111; 1984.

This technique is described for long-term identification of individual trees. Wires in place 25 years show signs of deterioration and should last at least another 15 years.

Smith, Neil I.; Smith, H. Clay; Miller, Gary W. **Residual stocking not seriously reduced by logging damage from thinning of West Virginia cherry-maple stands.** Res. Pap. NE-541. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 7 p.
North-central West Virginia, unmanaged 60-year-old cherry-maple stands were thinned to 75, 60, and 45 percent residual stocking. Cut trees were skidded tree by tree by a rubber-tired skidder. Logging destroyed or severely bent 22, 23, and 45 percent of the unmarked trees in the 75, 60, and 45 percent stocked plots, respectively. Because 99 percent of the destroyed and damaged trees were less than 5.0 inches d.b.h., the effect on basal area and residual stocking was slight. Damage reduced the stocking by 5, 8, and 8 percent in the 75, 60, and 45 percent plots, respectively. For the 75, 60, and 45 percent plots, 18, 38, and 42 percent, respectively, of the residual stems received wounds that exposed sapwood. Study results indicate that marking guidelines for trees larger than 5.0 inches d.b.h. do not need to be adjusted to account for logging damage.

Turner, J. A.; Reynolds, K. L.; MacLean, D. C., Jr.; Adler, G. W.; Dochinger, L. S. **Effects of sulfur dioxide on infection of red pine by *Gremmeniella abietina*.** In: Manion, Paul D., ed. *Scleroderris and other fungi of conifers: Proceedings of a symposium*; 1983 June 21-24; Syracuse, NY. Netherlands: Martinus Nijhoff/Dr. W. Junk; 1984: 122-129.
Relatively low doses of SO₂ significantly reduced the growth of red pine and inhibited infection of trees by *G. abietina* in field plots that received low concentrations of inoculum. Under conditions of high inoculum density, SO₂ did not affect infection or disease development.

Turner, J. A.; Auchmoody, L. R.; Carmean, Willard H. **Hardwood forest soils: Past, present, and future.** In: Stone, Earl, ed. *Forest soils and treatment impacts: Proceedings, 6th North American forest soils conference*; 1983 June 19-23; Knoxville, TN. Knoxville, TN: The University of Tennessee; 1984: 115.

Current knowledge about hardwood forest soils is vital to management of the vast hardwood forest resource in the United States. In the future, we need to develop: detailed site-oriented soil and landform inventories that will enable us to predict responses to a wide variety of silvicultural and management activities, more precise site analysis and yield information for important hardwood species, and practices that will maintain or improve the productivity of these forest lands. Also, we need more complete understanding of nutrient cycling budgets, nutrient requirements, and the use of nitrogen-fixing plants for enhancing fertility and improving forest yields.

LeDoux, Chris B. **Break-even zones for cable yarding by log size.** In: *Proceedings, Mountain logging symposium*; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 311-322.

The use of cable logging to extract small pieces of residue wood may result in low rates of production and a high cost per unit of wood produced. However, the logging manager can improve yarding productivity and break even in cable residue removal operations by using the proper planning techniques. In this study, break-even zones for specific young-growth stands were developed with data from a field study, break-even analysis, and a simulation model called THIN. Results suggest that logging contractors can break even by developing and using residue removal guidelines for various combinations of piece sizes and slope yarding distances. Simulation analysis was used to explore the effect on production rates of slope yarding distances, piece size distributions, and numbers of pieces per acre. For the \$76-per-hour machine used, the results of break-even analysis were most affected by piece size. Slope distance also had a strong impact. The number of pieces per acre had the least effect on production rates and costs.

LeDoux, Chris B. **Cable yarding residue after thinning young stands: a break-even simulation.** *Forest Products Journal*. 34(9): 35-40; 1984.
See previous abstract.

LeDoux, Chris B. **Production rates and costs of cable yarding wood residue from clearcut units.** *Forest Products Journal*. 34(4): 55-60; 1984.
Calculates incremental production rates and costs for yarding and loading logging residue in clearcut old-growth Douglas-fir/western hemlock forests in western Oregon. Cable yarding machines were used in the following configurations: highlead, shotgun skyline, running skyline, and skyline with haulback. Regression equations were developed for productive yarding time as a function of slope yarding distance, number of merchantable logs per turn, number of residue pieces per turn, merchantable volume per turn, and residue volume per turn. The average yarding production rate for turns containing both merchantable logs and residue pieces was 1,832 ft³/hr at a cost of \$0.18/ft³.

Leonard, R. E.; Conkling, P. O.; McMahon, J. L. **Recovery of a bryophyte community on Hurricane Island, Maine.** Res. Note NE-325. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.
Recovery of a bryophyte community on an artificially denuded granite ledge was monitored for 4 years on Hurricane Island, Maine. Predominant bryophyte species were *Dicranum polysetum*, *Polytrichum juniperinum*, *Dicranum flagellare*, *Polytrichum piliferum*, and *Dicranum fuscescens*. Site factors such as nutrient supply, moisture, and availability of reproductive material were considered in relation to bryophyte growth to assess the ability of a specific island plant community to recover from a major disturbance. Recovery of the bryophyte community was rapid, with 60 percent bryophyte coverage over a bare rock surface by the end of the study. There was a strong relationship between the amount of needlefall from a nearby spruce-fir stand

and the percentage of area covered with bryophyte species.

Lewis, F. B.; Wallner, W. E.; Rollinson, W. D. **Activity of *Lymantria* NPVs from the People's Republic of China against North American *Lymantria dispar*.** *Entomophaga*. 29(3): 299-302; 1984.

Six different geographical sources of *Lymantria dispar* (L.) and *Lymantria mathura* (L.) in the People's Republic of China (PRC) were sampled for nucleopolyhedrosis virus (NPV). Comparative bioassays of the *L. dispar* sources showed the U.S. Hamden standard to be more effective than the PRC nucleopolyhedrosis viruses. The *L. mathura* NPV equalled the effectiveness of the Hamden standard even after three passages in lab reared *L. dispar* larvae. This is the first report of *L. mathura* NPV effect on a U.S. strain of *L. dispar*.

Lewis, F. B.; Walton, G. S.; Dimond, J. B.; Morris, O. N.; Parker, B.; Reardon, R. C. **Aerial application of Bt against spruce budworm: 1982 Bt cooperative field tests—combined summary.** *Journal of Economic Entomology*. 77: 999-1003; 1984.

Three dosages (20, 30, 40 x 10⁹ IU[AI]/ha) and two rates (4.7 and 9.4 L/ha) of the *Bacillus thuringiensis* (Bt) product Thuricide 48B were applied aerially in Maine, Vermont, and Michigan. One dosage (30 x 10⁹ IU[AI]/ha) and three rates (2.4, 4.7, and 9.4 L/ha) were applied in Ontario. Percentages of foliage protection and population reduction in the United States were significantly better in all Bt treatments than in the controls, but Bt treatments were not significantly different from each other. In Ontario, all rates were not significantly different from the controls (P = 0.05). A relationship between Bt effectiveness and dose-volume was not evident in this test.

Lewis, Franklin B. **Formulation and application of microbial insecticides for forest insect pest management: problems and considerations.** In: Kaneko, T. M.; Akesson, N. B., eds. *Pesticide formulations and application systems: third symposium*; 1982 October; Fort Mitchell, KY. ASTM STP 828. Philadelphia, PA: American Society for Testing and Materials; 1984: 22-31.

Aerial applications for microbial insecticides such as *Bacillus thuringiensis* (Bt) and the Baculoviruses differ widely in effectiveness. The size and density of the droplets, the size and feeding rates of the larvae, the behavior of the insect, and the degradation of the insecticide after its application are among the controlling factors. Distribution of droplets of different sizes have been plotted and compared with the feeding rates of gypsy moth and spruce budworm larvae. In field tests, effectiveness was not always correlated with droplet density.

Luppold, William G. **An analysis of European demand for oak lumber.** Res. Pap. NE-538. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 7 p. Exports of oak lumber produced in the United States to major European demanders were analyzed using ordinary least squares estimation procedures.

Luppold, William G. **An econometric study of the U.S. hardwood lumber market.** *Forest Science*. 30(4): 1027-1038; 1984.

Hardwood lumber production and usage have remained roughly constant over the last 30 years while hardwood sawtimber supplies have increased. A recursive econometric model with the causal flow originating from the demand relationship was used to analyze this market. The results indicated that the availability of lower cost substitute materials and the economic uncertainty caused by the recursive aspects of the market have hindered market growth. The increase in nominal price of hardwood lumber is linked to the price of inputs (labor and stumpage) on the supply side of the market and the price of outputs on the demand side of the market. Nominal hardwood lumber price growth is ultimately linked to the general level of national economic activity and general rate of inflation via the effect that the macro economy exerts on prices of consumer goods and wage rates.

Luppold, William G.; Araman, Philip A. **Oak lumber exports to Europe: Past, present and future.** *Import/Export Wood Purchasing News*. 11(1): 3, 10, 18; 1984.

Lynch, J. A.; Rishel, G. B.; Corbett, E. S. **Thermal alteration of streams draining clearcut watersheds: Quantification and biological implications.** *Hydrobiologia* 111: 161-169; 1984.

Presents a quantitative evaluation of stream temperature alterations due to a commercial forest harvesting practice and a research treatment. Summer maximum stream temperatures averaged 1°C higher in the commercial clearcut and 9°C higher in the clearcut-herbicide watershed than in the forested control. The largest average monthly temperature increase on the commercial clearcut (2.2°C) occurred during April; on the clearcut-herbicide basin it occurred during June (10.5°C). Presents changes in minimum stream temperatures along with the impact on diel temperature fluctuations. Changes in the stream temperature regimes of the clearcut watersheds from the headwaters to the mouth of the watersheds are also given. Summarizes potential impacts of the stream temperature alterations on aquatic ecosystems in relation to stress limits for brook trout and other organisms.

McManus, Michael L. **Overwintering survival of fractured gypsy moth egg masses in forest litter.** *Melsheimer Entomological Series*. 33: 39-42; 1984. Fractured gypsy moth egg masses that overwintered in forest litter hatched in the spring just as well as intact egg masses on tree boles. Homeowners will not benefit from scraping egg masses into the litter, and in some areas, this practice may increase the survival of overwintering eggs.

McManus, Michael L.; Smith, Harvey R. **Effectiveness of artificial bark flaps in mediating migration of late-instar gypsy moth larvae.** Res. Note NE-316. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.

Field studies demonstrated that migrating larval instars of the gypsy moth preferred resting locations placed on

the boles at 4.6 m more than those placed at 1.5 and 3.1 m. More larvae were found beneath bark flaps than beneath flaps of hard black plastic.

Achado, C. C.; Gibson, H. G.; Biller, C. J. **Alcohol-fueled chainsaws: Results of Brazilian and American tests.** In: Proceedings, 1983 winter meeting American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. Paper No. 83-1603. St. Joseph, MI: American Society of Agricultural Engineers; 1983. 15 p.

Two-stroke cycle chain saws were tested in Brazil and the United States for performance using ethanol/vegetable oil fuel mixtures. Operational costs were found to be comparable with gasoline fueled saws in Brazil. Cold starting and other problems were noted from the U.S. testing.

Lanning, Robert E.; Callinan, Elaine A.; Echelberger, Herbert E.; Koenemann, Edward J.; McEwen, Douglas N. **Differential fees: Raising revenue, distributing demand.** Journal of Park and Recreation Administration. 2(1): 20-38; 1984.

The specific objectives of our study were to determine the ability of differential fees to redistribute demand and raise revenue. An experimental differential fee system--higher fees for the more popular campsites and lower fees for the less popular campsites--was implemented in three Vermont state parks during August 1982. User response to the differential fee system was closely monitored through observation of campsite selection and a user survey. The differential fee system resulted in more even distribution of campsite use and a small increase in total campground revenue. No discriminatory effects were found. Larger differentials than employed in this study will likely be needed to affect more substantive results. We recommend further application of differential fees under closely monitored conditions.

Marquis, David A.; Ernst, Richard L.; Stout, Susan L. **Prescribing silvicultural treatments in hardwood stands of the Alleghenies.** Gen. Tech. Rep. NE-96. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 90 p.

This publication brings together the results of more than 10 years of research and experience in the silviculture of hardwood forests in the Allegheny region. It provides a summary of silvicultural knowledge, guidelines, decision tables, and step-by-step instructions for determining silvicultural prescriptions in individual lands.

Martin, A. Jeff. **Testing volume equation accuracy with water displacement techniques.** Forest Science. 30(1): 41-50; 1984.

Water displacement was used to determine true volumes of 243 logs from 75 eastern hardwood trees ranging from 6 to 27 inches in d.b.h. Fourteen different equations were then used to estimate these volumes, and the results were compared to the true values in both accuracy and precision. The volume estimates were first made by using the measured log and tree dimensions. Next, heights and lengths were estimated with a taper function using specified diameter limits,

and the volumes were then estimated using these predicted values. Both tests were repeated for merchantable tree volume as well as log volume. One of the taper-based equations and two traditional volume equations performed best overall for various types of volume prediction.

Martin, C. Wayne; Buso, Donald C.; Hornbeck, James W. **Chemistry of remote ponds in the White Mountains of New Hampshire.** In: NADP Technical Committee Meeting; 1984 October 31 -November 2; Asheville, NC. (Location of publisher unknown: Publisher's name unknown); 1984: 8. Abstract.

The chemical characteristics of six remote ponds and their inlet streams in the White Mountains of New Hampshire were measured to estimate susceptibility to acid precipitation. The ponds are within 20 km of each other and have similar watershed characteristics and precipitation chemistry. The volume-weighted pH between ponds ranged from 4.5 to 6.4. Volume-weighted alkalinity ranged from 0 to 144 $\mu\text{eq/L}$. Alkalinity was related to pH, basin morphology, production of hypolimnetic alkalinity, and chemistry of inlet streams. Volume-weighted SO_4^{2-} ranged from 70 to 170 $\mu\text{eq/L}$ among the ponds. The ratios of divalent cations balancing SO_4^{2-} suggest that weathering within the watersheds is an important factor in buffering acid precipitation and pond acidity.

Martin, C. Wayne; Noel, Diane S.; Federer, C. Anthony. **Effects of forest clearcutting in New England on stream chemistry.** Journal of Environmental Quality. 13(2): 204-210; 1984.

Differences in stream chemistry between recently clearcut and nearby uncut watersheds were generally small in a wide variety of soil and forest types throughout New England. Water samples were collected during 6 periods of the year in 1978 and 1979 from 6 entirely clearcut, 32 partially clearcut, and 18 uncut watersheds. The largest differences that could be attributed to harvesting occurred in entirely clearcut watersheds, especially in the White Mountains of New Hampshire. In one area of the White Mountains, inorganic nitrogen was 4 times higher (2 mg/L), and calcium was 2 times higher (4 mg/L) in streams from a clearcut watershed than in a nearby uncut watershed. Elsewhere only minor changes in stream chemistry resulted from cutting; the amount of the cutting response was of the same magnitude as natural variations among streams draining similar watersheds. Clearcutting less than entire watersheds, patch and strip cuts, and buffer strips along streams, all seem to reduce the magnitude of changes in stream quality.

Marty, Robert. **A program for evaluating the economic effectiveness of spruce budworm control with a programmable hand-held calculator.** Gen. Tech. Rep. NE-92. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 10 p.

Uncontrolled spruce budworm infestations can cause substantial losses of spruce-fir. With this program, a hand calculator can compute the net present worth and composite rates of return of control investments, before and after taxes. A worked-out example is given. If input-output forms are prepared in advance, as sug-

gested, the calculator can be used without a printer in the field to generate on-the-spot estimates.

Mazzone, H. M.; Engler, W. F.; Bahr, G. F. **Quantitative transmission electron microscopy for the determination of mass-molecular weight of viruses.**

Methods in Virology. 8: 103-142; 1984.

Describes a method for obtaining the mass-molecular weight of viruses. Determining the mass of a virus particle after exposing it untreated in the electron microscope adds an important dimension to size and shape. Two transmission values are recorded for each virus particle: 1) transmission through the viral image plus background, and 2) transmission through the background (clear area). Subtracting the latter from the former gives the transmission of the virus. If a standard particle, i.e., one whose mass-molecular weight is known, is treated in an identical manner, the mass-molecular weight of the virus particle can be calculated.

Mazzone, H. M.; Wray, G. **High-voltage electron microscopy of insect capsule viruses.** In: Bailey, G. W., ed. Proceedings of the 42nd annual meeting of the Electron Society of America; 1984 August 13-17; Detroit, MI. San Francisco, CA: San Francisco Press, Inc.; 1984: 224-225.

The High-Voltage Electron Microscope (HVEM) affords the researcher an opportunity to study insect virus inclusion bodies, intact, without resorting to physical thin-sectioning or chemical degradation procedures. In this manner polyhedral inclusion bodies, isolated from insects infected with nucleopolyhedrosis viruses (NPVs) were observed with the HVEM, and the numerous viruses lying internally, clearly delineated.

Melhuish, J. H.; Wade, G. L. **Changes in fatty-acid content of *Pisolithus tinctorius* due to common soil phenolic compounds.** Transactions of the Kentucky Academy of Science. 45(1-2): 98; 1984. Abstract. Mycorrhizal development on surface mine spoils may be inhibited by compounds produced by some herbaceous covers. Ferulic, p-coumaric, and vanillic acids inhibited in vitro growth of *Pisolithus tinctorius*. All these compounds are produced by some grasses. Concomitant effects included an increase in total lipids and the conversion of 18:1 fatty acid to 18:2. Changes in concentration of phenolic compounds influenced leakage of materials from the mycelium into the media. This suggests that allelopathic effects initial *P. tinctorius* early in ecosystem development. Increasing media nutrient content, although itself toxic to fungal growth, nullified the effects of ferulic acid.

Melhuish, J. H., Jr.; Wade, G. L. **Degradation of synthetic glucose-ammonium tartrate liquid medium during autoclaving.** Mycologia. 76(1): 161-162; 1984.

Glucose-ammonium tartrate has been used for decades in culture media for fungi. We autoclaved large volumes of a glucose-ammonium tartrate in flasks. Upon cooling, a patchy oil-like film formed on the surface of the medium that developed into a dark brown, short, thread-like precipitate. When the ratio of the media surface area to air volume in the flasks fell below 0.16, a film and/or precipitate was observed. Preventing

precipitate formation by keeping the media surface area to air volume ratio above 0.16 may preclude undesirable effects on the results of microbial development on glucose-ammonium tartrate media.

Miller, Gary W. **Costs of reducing sapling basal area in thinned cherry-maple stands in West Virginia.** Res. Pap. NE-540. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 6 p.

Unmanaged 60-year-old cherry-maple stands in West Virginia were thinned to three levels of stocking according to the Allegheny hardwoods stocking guide. After the merchantable timber was removed, the basal area in saplings was reduced to less than 10 ft² per acre, as the guide recommends for stands with dense understories. A detailed timber study revealed that cutting saplings with chain saws costs about \$17.00 per acre. This amount may be recoverable in increased yield, tax deductions, and fuelwood sales.

Miller, Gary W. **Releasing young hardwood crop trees—use of a chain saw costs less than herbicides.** Res. Pap. NE-550. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 5 p.

A crown-touching release of 12-year-old black cherry and yellow-poplar crop trees on a good site required removing an average of 14 trees for every crop tree. An average of 80 crop trees per acre was left free-to-grow with an average growing space of 4.7 feet on all sides of the crown. Basal spraying cost \$0.80 per crop tree, stem injecting cost \$0.61 per crop tree, and chain saw felling cost \$0.42 per crop tree. Recommendations on release methods and suggestions for cost savings are provided.

Miller, Gary W.; Lamson, Neil I.; Brock, Samuel M. **Logging damage associated with thinning central Appalachian hardwood stands with a wheeled skidder.** In: Proceedings, Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 125-131.

In north-central West Virginia, unmanaged 53-year-old, mixed oak-cove hardwood stands were thinned to 75, 60, and 45 percent residual stocking. Cut trees were skidded tree-length with a rubber-tired skidder. Logging destroyed or severely bent 26, 29, and 34 percent of the unmarked stems in the 75, 60, and 45 percent stocking plots, respectively. Because 94 percent of the destroyed and bent trees were less than 5.0 inches d.b.h., the effect on basal area and residual stocking was slight. Damage reduced the stocking by 6, 4, and 5 percent in the 75, 60, and 45 percent stocking plots, respectively. All plots combined, 14 percent of the residual stems sustained broken tops, which affected only 3 percent of the residual basal area. Less than 10 percent of the residual stems received wounds that resulted in exposed sapwood. Study results indicate that marking guidelines in the merchantable portion of the stand do not need to be adjusted to account for logging damage.

Montgomery, Michael E. **Is the effect of tannins on gypsy moth caterpillars digestion inhibition?** In: Proceedings, Phytochemistry Society of America. 24(2): 27; 1984. Abstract.

Addition of either tannic acid or condensed tannin to artificial diets fed to gypsy moth resulted in up to 50 percent reduction in growth rate. Tannin levels from 0.1 to 1 percent dry weight were increasingly active. Tannin levels from 1 to 10 percent, a range frequently found in host leaves, did not differ in activity. Reduction in diet consumption, growth rate, or nitrogen utilization efficiency did not occur until after 5 days of continuous feeding on tannin diets. These results do not indicate that tannin was adversely affecting food digestion, but are suggestive of an effect such as interference with absorption of trace minerals or vitamins. Effect of tannins on gypsy moth proteolytic enzymes is also being examined. These results raise questions about the appropriateness of currently used astringency tests to estimate the biological activity of tannins to caterpillars.

Montgomery, Michael E. **Review of: Variable plants and herbivores in natural and managed systems;** Denno, Robert F.; McClure, Mark S., eds. *Bulletin of the Entomological Society of America*. 30(4): 60-61; 1984.

Montgomery, Michael E.; Czapowskyj, M. **Nitrogen as an indicator of foliage quality to the spruce budworm.** In: Abstracts, Spruce budworms research symposium; 1983 September 16-20; Bangor, ME. Washington, DC: U.S. Department of Agriculture, Forest Service, Canada-United States Spruce Budworms Program; 1984: 26. Abstract.

It has been hypothesized that population fluctuations of foliage-eating insects are a result of changes in food supply. The level of nitrogen and chemicals in foliage influencing nitrogen utilization are often cited as factors that determine the nutritional quality of foliage. Spruce budworm outbreaks have been associated with host species, host maturity, site condition, and weather-induced tree stress.

More, Thomas A. **Hunting: A theoretical explanation with management implications.** *Wildlife Society Bulletin*. 12: 338-344; 1984.

Discusses a mathematically based theory of hunting behavior that integrates concepts from the multiple-satisfactions theory of hunting with concepts from the theory of achievement motivation and expectancy-value theory. The theories are used to explain how individual hunters differ, how their attitudes can change with time, and how they select a hunting site. The analysis is extended to other sources of satisfaction such as esthetics and companionship.

More, Thomas A. **Municipal forest management: A Massachusetts survey.** *Journal of Forestry*. 82(7): 117-119; 1984.

In New England, municipalities control substantial amounts of forest land that could benefit from management. A survey of municipalities in Massachusetts estimated that they administer some 288,000 acres. Many municipal officials are interested in placing their land under forest management, but are not sure how to obtain forestry information. Urban and community forestry programs operated by the states can provide a valuable service to communities, helping municipal officials understand and evaluate forest-management options.

Morin, Michael J.; Demeritt, Maurice E., Jr. **A nursery guide for propagating poplars.** NE-INF-56-84. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 19 p.

The guide presents basic techniques for nursery propagation of unrooted and rooted poplar cuttings.

Norris, Logan A.; Montgomery, M. L.; Loper, B. R. **Movement and persistence of 2,4,5-trichlorophenoxyacetic acid in a forest watershed in the eastern United States.** *Environmental Toxicology and Chemistry*. 3: 537-549; 1984.

Approximately 98 percent of a 22-ha watershed in West Virginia was sprayed with 2.24 kg/ha of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in August 1975. Herbicide residues in four species of vegetation, forest floor soil, and stream water were monitored for 2 years and found to be substantially below levels likely to cause any adverse effects in animals.

O'Brien, James T. **Historical and current Scleroderris situations in the United States.** In: Manion, Paul D., ed. *Scleroderris canker of conifers: Proceedings of a symposium*; 1983 June 21-24; Syracuse, NY. Netherlands: Martinus Nijhoff/Dr. W. Junk; 1984: 26-31.

Scleroderris canker was first noticed in North America in the Upper Peninsula of Michigan in 1951. When the causal organism, *Gremmeniella abietina* (North American race), was identified in 1964, the disease was already widespread there and in northern Wisconsin, and in 1969 it was discovered in Minnesota. Most infection was traced to a nursery in Michigan, and spread declined once nursery infection was arrested. In 1959, the disease, later attributed to the European race, was discovered in New York, where it now occupies 16,300 km²; it has also been found in Vermont, New Hampshire, and Maine. Quarantines apparently prevent artificial spread, but natural spread will continue.

ODell, Thomas M.; Bell, Robert A.; Mastro, Victor C.; Tanner, John A.; Kennedy, Leonard F. **Production of the gypsy moth, *Lymantria dispar*, for research and biological control.** In: *Advances and challenges in insect rearing*. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service; 1984: 156-166.

The first attempt to rear the gypsy moth in the laboratory in the United States occurred in 1868 and resulted in its escape and establishment in Medford, Massachusetts. This notorious European forest pest was brought to the United States from France by Professor Leopold Trouvelot, an astronomer and naturalist who was trying to breed a new silkworm. His experiment led to the creation of a pest-control industry that has flourished since the first major outbreak in 1889.

ODell, Thomas M.; Godwin, Paul A. **Host selection by *Blépharipa pratensis* (Meigen), a tachinid parasite of the gypsy moth, *Lymantria dispar* L.** *Journal of Chemical Ecology*. 10(2): 311-320; 1984.

The host selection process of *Blépharipa pratensis* (Meigen), a tachinid parasite of the gypsy moth, was investigated. Once in the host's habitat, and following contact with a recently damaged leaf edge (cut, torn,

eaten), the fly orients perpendicular to the edge and moves back and forth with the front tarsi grasping the damaged edge. Oviposturing (oviposition intention) may occur. Leaf exudates appear to arrest the fly on the leaf and increase tarsal examination (searching). If an edge of a gypsy moth-eaten leaf is contacted, oviposition usually occurs. A host selection sequence is suggested and discussed.

Ostrofsky, W. D.; Shortle, W. C.; Blanchard, R. O.
Bark phenolics of American beech (*Fagus grandifolia*) in relation to the beech bark disease.
 European Journal of Forest Pathology. 14: 52-59; 1984.

The amount of total extractable phenols was determined for bark sections obtained from behind cankers naturally induced by *Nectria coccinea* var. *faginata* and from behind mechanically inflicted wounds on stems of American beech. Healthy bark from susceptible trees was found to contain a similar level of phenolics as bark from trees determined to be resistant to the beech bark disease. Six months after wounding, wound-altered bark from susceptible trees was found to be lower in phenols than wound-altered bark from resistant trees. Inoculation of wounds with *N. coccinea* var. *faginata* resulted in decreased phenolic levels in bark sections nearest the wound surface, and increased phenolic levels in sections nearest the vascular cambium, several mm distant. Phenolic levels in injured or infected bark appear to follow similar patterns as those resulting from injury or infection of xylem tissues.

Palmer, James F. **Neighborhoods as stands in the urban forest.** Urban Ecology 8(4): 229-241; 1984.

This paper reports the results of a study investigating the neighborhood stand concept for describing the variation in the character and perceptions of the urban forest in three neighborhoods identified by 22 community service workers in Syracuse, New York. We interviewed 261 people in these neighborhoods. Neighborhoods are investigated for patterns with respect to: (1) household demographics; (2) evaluations of city-wide issues; (3) perceived neighborhood characteristics; (4) desired house and yard qualities; and (5) the physical condition of structures and vegetation. Several neighborhood-related patterns are found to exist. In particular, the perception of neighborhood quality is more related to neighborhood location than respondent characteristics and most related to the physical condition of the immediate surrounding environment.

Patric, James H.; Evans, James O.; Helvey, J. David.
Summary of sediment yield data from forested land in the United States. Journal of Forestry. 82(2): 101-104; 1984.

Statistical analyses were made on 812 forest soil erosion measurements and estimates of sediment yield in forest streams. More than 100 of those reports showed that streams draining forested land along the Pacific Coast yield far more sediment per unit area of watershed than do streams of forested regions elsewhere in the nation. The nationwide results are consistent with regional compilations. A long-term average of not more than 0.25 ton per acre per year in streams of the eastern and western United States can provide a first approximation of sediment yield from predominantly forested land.

Peacock, John W.; Wright, Susan L.; Ford, Robert D.
Elm volatiles increase attraction of *Scolytus multistriatus* (Coleoptera: Scolytidae) to multilure. Environmental Entomology. 13(2): 394-398; 1984.

Traps baited with multilure and bolts of healthy American elm captured significantly more beetles than traps baited only with multilure. The elm bolt-multilure combination was 2 to 3 times as attractive as multilure and 4 to 18 times as attractive as elm bolts alone. The increased attraction from the presence of healthy elm tissue suggests that additional host volatiles, other than those formulated in multilure, contribute to the aggregation of beetles on host trees.

Peters, Penn A. **Steep slope clearcut harvesting with cable yarders.** In: 1984 Proceedings, Harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society; 1984: 69-78.

Presents a procedure to estimate the yarding production and cost of cable yarders harvesting clearcuts on steep slopes. A mathematical equation for the production that can be obtained by the cable yarder is derived. The procedure is applied to a typical cable yarder operating in the eastern United States. The effect of harvest unit geometry and volume per acre on production and cost is discussed.

Podgwaite, J. D. **The status of nucleopolyhedrosis virus in gypsy moth management.** In: Miller, A. R., ed. National gypsy moth review: Proceedings of a symposium; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plant Pest Control Division; 1984: 92-93.

Podgwaite, John D.; Rush, Peter; Hall, David; Walton, Gerald S. **Efficacy of the *Neodiprion sertifer* (Hymenoptera: Diprionidae) nucleopolyhedrosis virus (*Baculovirus product*, Neochek-S.** Journal of Economic Entomology. 77: 525-528; 1984.

Neodiprion-sertifer (Geoffroy) larval populations were treated with high and low doses of a nucleopolyhedrosis virus (NPV) product, Neochek-S. Larval population reduction due to Neochek-S was well over 90 percent in all sprayed plots 28 days after application, whereas overall protection of *Pinus resinosa* (Ait.) foliage was 94.0 ± 1.6 percent. The difference between doses was insignificant with respect to population reduction or foliage protection. A dose rate of 2.5 x 10⁹ polyhedral inclusion bodies of *N. sertifer* NPV/ha, by ground application, provided acceptable control in a plantation infested with moderate to dense populations of the insect.

Powell, Douglas S. **Yankee ingenuity and the hardwood resource.** Northern Logger. 32(10): 34-35, 54, 56-59; 1984.

The hardwood timber resource of New England has been largely overlooked by the nation and the region itself. The size and quality of the timber may not be high, but the quantity and potential for more is overwhelming. Forest industry is important in certain localities, but it has not reached its full potential. Utilization is on the rise, and New England is pioneering new opportunities for efficient and profitable use of this renewable resource. Research is continuing along several fronts.

the outlook for this resource and this region looks bright.

Bowell, Douglas S.; Dickson, David R. **Forest statistics for Maine: 1971 and 1982.** Resour. Bull. NE-81. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 194 p.

A statistical report on the third forest survey of Maine (1982) as well as reprocessed data from the second survey (1971). Results of the surveys are displayed in 19 tables containing estimates of forest and timberland area, numbers of trees, timber volume, tree biomass, timber products output, and components of average annual net change in growing-stock volume for the period between surveys. These estimates were developed by several classifications including forest type, ownership, species, size, and quality. Data are presented at three levels: state, geographic sampling unit, and county.

Rademacher, P.; Bauch, J.; Shigo, A. L. **Characteristics of xylem formed after wounding in *Acer*, *Betula*, and *Fagus*.** IAWA Bulletin. 5(2): 141-151; 1984. Characteristics of xylem formed after wounding were determined for *Acer saccharum*, *Betula alleghaniensis*, and *Fagus grandifolia*. There was a basic pattern of changes in xylem formed after wounding in all trees studied. The xylem formed after wounding contained more ray and axial parenchyma and less fibers and vessels than xylem present at the time of wounding. The radial tissues were disoriented. The vessels were smaller in length and diameter than normal vessels and the fibers were shorter. In some trees, normal xylem did not begin to form until 2 years after wounding. Some individual trees within each species compartmentalized discolored wood effectively to small columns while other trees had large columns.

East, Everette D. **How to recognize and assess surface defect indicators of logs and trees.** In: Corcoran, Thomas J.; Fosbroke, David E., eds. Changing markets—changing forestry: Abstracts of proceedings; 1984 March 7-9; Worcester, MA. SAF Publ. No. 84-04. Bethesda, MD: Society of American Foresters; 1984: 13. Abstract.

Remington, Susan B.; Sendak, Paul E. **Massachusetts timber economy: A review of the statistics.** Boston, MA: Massachusetts Department of Environmental Management, Division of Forests and Parks; 1984. 28 p.

Summarizes current information available on the forests of Massachusetts and the State's timber-based industries.

Remington, Susan B.; Sendak, Paul E. **New Hampshire's timber economy: A review of the statistics.** Durham, NH: University of New Hampshire, New Hampshire Cooperative Extension Service; 1984. 28 p.

More than 87 percent of the land area of New Hampshire is forested. It is second only to Maine as the most heavily forested state. The forest provides a base for many of New Hampshire's timber-based industries and those that depend on tourism. The first section pre-

sents information on the timber resource and the timber-based industries; the second, measures the economic significance of timber, especially in relation to the other industries in New Hampshire.

Remington, Susan B.; Sendak, Paul E. **New York State's timber economy: A review of the statistics.**

Albany, NY: New York State Department of Environmental Conservation, Division of Lands and Forests, Bureau of Forest Marketing and Economic Development; 1984. 30 p.

Remington, Susan B.; Sendak, Paul E. **Potential effects of the fuelwood market on wood-using industries in northern New England and New York.** Res. Note NE-323. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.

The increased use of fuelwood in northern New England and New York has raised concern about future supplies of manufactured wood products. Direct effects were measured by estimating the competitive advantages of the kraft pulp, waferboard, and oriented strand board industries in purchasing wood. Increased stumpage prices in the region would have the greatest impact on the reconstituted board industries.

Rexrode, C. O.; Baumgras, J. E. **Distribution of gum spots by causal agent in black cherry and effects on log and tree quality.** Southern Journal of Applied Forestry. 8(1): 22-28; 1984.

Gum spots were studied in 116 black cherry trees in West Virginia. Bark beetles are the major cause of gum spots in both black cherry poletimber and sawtimber trees. Approximately 90 percent of all gum spots in the bole sections are caused by bark beetles. Cambium miners cause few gum spots in the lower 6 m of the trees and virtually none in the quality zone. Bark beetle-caused gum spots are grade defects in both veneer and factory grade sawlogs. Cambium miner-caused gum spots cause little degrade in veneer logs and none in factory grade 1 and 2 sawlogs.

Reynolds, Hugh W. **System 6: Rough-mill operating manual.** Res. Pap. NE-542. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 27 p.

Includes operating instructions for the System 6 rough mill. Techniques are shown for making standard-size blanks, in all lengths, for each of 13 blank quality/width/thickness combinations.

Reynolds, Hugh W. **Using West Virginia's lower grade hardwood resource.** In: Dempsey, Gilbert P.; Price, Karen S., eds. Governor's conference on West Virginia's forest industry. Workshop Proceedings; 1983 November 7-8; Charleston, WV. Charleston, WV: Governor's Office of Economic and Community Development and West Virginia Forests, Inc.; 1984: 118-112.

Reynolds, Hugh W.; Hansen, Bruce G. **A sample plant design for System 6.** Gen. Tech. Rep. NE-87. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 8 p.

A plant to make standard blanks from cants by System 6 can be assembled from off-the-shelf equipment with few modifications. From the production rates and manpower requirements of each piece of equipment, we designed a typical plant and determined by economic analysis that it could return 21 percent on an investment of \$2 million by making blanks for sale from purchased cants.

Rice, William W.; Gatchell, Charles J. **Kiln drying procedures for northern red oak.** In: Proceedings, Western dry kiln clubs; 1983 May 4-6; Corvallis, OR. Corvallis, OR: Oregon State University; 1984: 80-88.

Robison, D. J.; Czapowskyj, M. M.; Abrahamson, L. P.; White, E. H. **Spruce budworm characteristics and foliar nutrient—Site relationships in black spruce.** In: Abstracts, Spruce budworms research symposium; 1983 September 16-20; Bangor, ME. Washington, DC: U.S. Department of Agriculture, Forest Service, Canada-United States Spruce Budworms Program; 1984: 23. Abstract.

Relationships between spruce budworm characteristics and site influences including foliar organic and inorganic nutrient levels, soils, and silvicultural treatments were investigated in a young (ca. 25 years) black spruce stand in northern Maine. The influence of foliar N, P, K, Ca, Mg, phenols, flavonoids, and sugars; soil N, P, K, Ca, and Mg; and silvicultural treatments of fertilization, drainage, thinning, and slash removal on budworm population, pupal size, and sex ratio were statistically analyzed from a replicated field experiment. Foliar, soil, and budworm data are presented.

Rothwell, Frederick M.; Victor, Barbara J. **A new species of Endogonaceae: *Glomus botryoides*.** Mycotaxon. 20(1): 163-167; 1984.

Glomus botryoides, a new species of the Endogonaceae, was observed in wet-sieved stomach contents of two small mammalian mycophagists that were trapped in a wildlife management area in which oak was the predominant plant cover. Chlamydospores of the new species have a distinct toughened surface and a separable outer wall, and often form in tight, grape-like clusters from bulbous endings of hyphae.

Rowntree, Rowan A. **Ecology of the urban forest — introduction to part I.** Urban Ecology. 8: 1-11; 1984.

This first of two special issues on urban forest ecology offers new empirical work describing forest structure and composition. Four avenues of inquiry are pursued in this introductory paper with the purpose of setting the contributions of the special issue in context of the existing literature. First, in temperate regions of the world, it is likely 60 to 80 percent of a city's area supports enough trees to meet conventional definitions of "forest." Second, the geographical distribution of canopy cover is understood best as dependent upon the historical development of the city and its division into land-use sectors. Third, physiognomy is poorly understood and varies widely depending on the amount and kind of human intervention in the colonization and regeneration processes. Fourth, dominance and diversity are likely to be hotly debated questions of urban forest

structure because of lack of agreement as to what constitutes a "good" composition. Finally, a typology of urban forest structure is needed to be followed by historical explanations of how biology and human agency combine to bring about these structures.

Rowntree, Rowan A. **Forest canopy cover and land use in four eastern United States cities.** Urban Ecology. 8(1/2): 55-67; 1984.

Four cities in the Eastern United States were divided into 10 land-use classes and measured for canopy cover with black-and-white, monoscopic aerial photographs. Mean citywide canopy cover is 24 to 37 percent, with a range of 5 to 60 percent for the mean canopy coverage of 10 land uses. Available space for growing trees is 55 to 66 percent of the sample cities' area; the percentage of that space filled with canopy is 37 to 57 percent. The dominant land-use class, one- and two-family residential covering an average of 46 percent of the cities' area, shows little variation in both canopy cover and canopy stocking within the sample and, where available growing space increases, so does canopy stocking. Vacant land is second in areal coverage (14 percent of cities' area), and varies only moderately in canopy cover and stocking when the values in this class are divided into abandoned and undeveloped land. Regularities in the spatial distribution of canopy, among the sample cities, occur as a result of the location and extent of land use.

Sarles, Ray; Reid, Stuart. **Tannery solves air pollution problems.** Northern Logger. 32(11): 6-7; 1984.

Locally abundant wood residues, more economical than coal, are used to produce high-pressure steam for generating power and processing hides and leather in a modern wood-burning plant of 60,000 lb/h capacity. Stack emissions meet or exceed West Virginia air-pollution standards, and fuel cost savings and boiler performance surpass management's expectations.

Sarles, Raymond L.; Wartluft, Jeffrey L.; Whitenack, Kenneth R. **Chain-saw felling in hardwood thinnings.** In: Harvesting the South's small trees: FPRS conference; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society; 1984: 141 p.

Production and efficiency rates were computed from time study and stem measurement data from four hardwood thinning operations in the central Appalachians. Felled trees averaged 9 to 10 inches in d.b.h. and 38 to 45 feet in merchantable length. Hourly production rates were determined from a regression equation expressing productive felling time as a function of merchantable volume and distance between successively felled trees. The average production rate for the combined operations was 2.4 cords per hour at an average felling efficiency of 49 percent. Efficiency was inversely related to delay time. Causes of delay—the largest time block in each felling cycle—were analyzed. Specialized training in thinning methods and techniques was recommended to increase worker efficiency and productivity.

Sarles, Raymond L.; Whitenack, Kenneth R. **Costs of logging thinnings and a clearcutting in Appalachia using a truck-mounted crane.** Res. Pap. NE-545. Broomall, PA: U.S. Department of Agriculture,

- Forest Service, Northeastern Forest Experiment Station; 1984. 9 p.
- Investigates the effects of thinning and clearcutting on the cost of logging using a truck-mounted crane for felling and chain saws for felling. Work measurements of the harvesting operations were conducted on 4-acre blocks of timber marked for thinning and 4-acre clearcut. Worker efficiency and productivity were higher for thinning than for clearcutting. Reason for the difference are discussed. Comparisons of logging costs among the four cuttings showed that the cost of wood delivered to roadside was less for logs removed from the thinned blocks than from the clearcut. Silvicultural and environmental aspects of truck-mounted logging are discussed.
- Waller, Paul W.; Jingjun, Yan; Xilin, Sun; Wallner, William E.; Weseloh, Ronald M. **Natural enemies of the gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae) in China.** *Scientia Silvae Sinicae*. 18(4): 435-440; 1984.
- 2-month survey of the natural enemies of the gypsy moth in Beijing and the northeastern People's Republic of China confirmed the presence of 22 parasitic species in the genera *Hexameris*, *Exorista*, *Carcelia*, *Pterigena*, *Chetogena*, *Blepharipa*, *Elachertus*, *Anatopis*, *Tyndarichus*, *Rogas*, *Meteorus*, *Glyptapanteles*, *Apanteles*, *Phobocampe*, *Casiniaria*, *Hyposoter*, *Microplitis*, and *Ephialtes*, and 12 predatory species in *Stenobothrus*, *Harpactor*, *Epidaus*, *Picromerus*, *Dimorpha*, *Pinthaeus*, *Xylodrepa*, *Carabus*, and *Calosoma*. Species diversity was greatest at Menjiagang, Heilongjiang Province. Populations were low in 10 other collection sites. Nucleopolyhedrosis virus was moderately abundant while the fungus *Entomophthora aulicae* was abundant in some collected larvae and was evident in yearling sawflies.
- Waller, Paul W.; Wallner, William E.; Ticehurst, Mark. **Incidence of the black-backed larval mutant of *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae) in Ukrainian SSR.** *The Journal of Research on the Lepidoptera*. 23(1): 103-104; 1984.
- Charles T. **A new look at sampling with partial replacement.** *Forest Science*. 30(1): 157-166; 1984.
- Estimators for use with sampling with partial replacement (SPR) on two occasions are reviewed. Estimation of both current values and change in those values is considered. Given that population variances and covariances are unknown, estimators are presented that are improvements over those suggested in the literature. An example of the use of the estimators is provided.
- Charles T. **A case for point samples.** In: *Proceedings of the forest land inventory workshop, Preparing for the 21st century*; 1984 March 26-30; Denver, CO. Washington, DC: USDA Forest Service, Division of Timber Management; 1984: 22-257.
- Point sampling is a method of locating sample plots in a sampling frame. Point sampling as defined here differs from Bitterlich horizontal point sampling. Point sampling compared with mapped sampling, and advantages and disadvantages described. Recommendations are given for estimating mapped area characteristics using point sampling techniques.
- Sendak, P. E.; Morselli, M. F. **Reverse osmosis in the production of maple syrup.** *Forest Products Journal*. 34(7/8): 57-61; 1984.
- Reverse osmosis (RO), a membrane process for separating water from a solution, was evaluated for use in the production of maple syrup. The process had lower costs compared to all thermal evaporation over the range of annual production studied. The difference in cost increased with increasing size of production from 2,000 taps (15,000 gallons of sap) to 20,000 taps (150,000 gallons). The syrup made from RO concentrate was equal in color and flavor to syrup made conventionally. Synthetic-membrane technology offers an alternative to thermal separation and had many applications.
- Sheehan, Katharine A. **Development of forest-gypsy moth models.** In: Miller, A. R., ed. *National gypsy moth review: Proceedings of a symposium*; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plant Pest Control Division; 1984: 99-102.
- Development of forest-gypsy moth models is an important part of the mission of a new Northeastern Forest Experiment Station Research Work Unit titled "Silvicultural Options for the Gypsy Moth." This effort focuses on the need to develop a decision-support system to assist resource managers in evaluating management strategies for the gypsy moth. Computer models that simulate forest growth and yield (under a range of management practices), gypsy moth population dynamics, and forest-gypsy moth interactions will be key components of such a system. This review will briefly describe the current model and will outline future plans for model development.
- Shields, K. S. **An association between microtubules and nucleocapsids in nucleopolyhedrosis virus-infected hemocytes and fat body in the gypsy moth.** In: Bailey, G. W., ed. *Proceedings of the 42nd annual meeting of the Electron Microscopy Society of America*; 1984 August 13-17; Detroit, MI. San Francisco, CA: San Francisco Press, Inc.; 1984: 222-223.
- An unusual relationship was observed between microtubules and nucleocapsids in nucleopolyhedrosis virus-infected hemocytes and fat body cells in the gypsy moth. Nucleocapsids were parallel to, and closely associated with, microtubules in both the cytoplasm and the nucleus. These findings suggest that this virus might utilize the filament system of the host cell for movement within the cell.
- Shigo, Alex L. **Compartmentalization: A conceptual framework for understanding how trees grow and defend themselves.** *Annual Review of Phytopathology*. 22: 189-214; 1984.
- Describes a conceptual framework for understanding how trees grow and how they and other perennial plants defend themselves.
- Shigo, Alex L. **Homeowner's guide for beautiful, safe, and healthy trees.** NE-INF-58-84. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 8 p.
- The topics covered are: proper planting, wound dressings, correct pruning, potential hazards, and insects and microorganisms.

Shigo, Alex L. **How to assess the defect status of a stand.** Northern Journal of Applied Forestry. 1(3): 41-49; 1984.

The defect status of trees in a stand is a major factor affecting the value of trees. Understanding the cluster effect of tree defects allows rapid assessment of the defect status of trees in a stand. Some common tree defects that occur in clusters are: stem stubs, poorly closed stubs, canker rots, perennial cankers, basal cracks, root rots, bird pecks, sugar maple borer and ambrosia beetle injuries, defects in sprouts, and wounds made by logging, fire, and animals. The information is illustrated and should help you determine the quality of the wood in the stand, and the best treatment for the stand.

Shigo, Alex L. **The right treatments for troubled trees.** American Forests. 90(2): 13-16; 1984.

Many myths and misconceptions about trees and treatments have developed over the centuries—such as the beliefs that wound paints stop rot, that frost starts the long deep cracks called "frost cracks," that heartwood is a dead tissue, and many more. Some basic information about trees and treatments may help. It is time to go back to the basics and attack tree problems from the view of the tree, rather than from the view of the problem. We must focus not on what makes trees sick, but on what keeps them healthy.

Shigo, Alex L. **Tree decay and pruning.** Arboricultural Journal. 8(1): 1-12; 1984.

Trees respond to injuries and infections by setting boundaries to resist the spread of microorganisms. The boundaries also resist the spread of microorganisms from dying branches into the joining stem. Pruning cuts should not be made behind the branch bark ridge. Such cuts remove the protective boundaries, allowing microorganisms to spread rapidly into the stem. When branches are pruned properly, there is no need for wound dressings. When branches are pruned improperly, no amount or type of wound dressing will help.

Shigo, Alex L. **Tree survival after injury and infection.** In: Proceedings, 8th North American forest biology workshop; 1984 July 30 - August 1; Logan, UT. Logan, UT: Utah State University; 1984: 11-23.

Trees survive after injury and infection so long as they have the time, energy reserves, and genetic capacity to compartmentalize injured and infected tissues rapidly and effectively to small volumes, and to generate enough new tissues in new spatial positions to store enough energy to maintain the tree. Trees have many protection features and a defense system. The defense system is centered about compartmentalization, which is a boundary-setting process to resist spread of pathogens. Tree pathogens survive so long as they can spread fast and far enough to gain enough space and energy to reproduce. Trees and pathogens interact under the constant pressure of the ever-changing environment. A tree is reexamined from the view of its boundary-setting defense system. When branch development is clarified, proper pruning methods become obvious. When boundary-setting is understood to be under strong genetic control, trees resistant to spread of decay can be selected for our forests. When tree decay is clarified, the major cause of damage to trees worldwide can be reduced.

Shigo, Alex L. **Trees and discoloured wood.** IAWA Bulletin. 5(2): 99; 1984.

Discoloured wood is wood altered by injury and infection. The wood usually is a colour different from sound, normally aging wood—sapwood or heartwood. The cell contents in discoloured wood usually are altered and cell walls may be coloured but not digested; there is no reduction in specific gravity. Discoloured wood may be more protective or less protective than contiguous wood. Discoloured wood is wood in transition—a long gradation of irreversible changes as moisture content, concentration of ions, and the succession of many organisms change over time. Tree and wood-inhabiting organisms interact over time and space as all are affected by the ever-changing environment.

Shigo, Alex L. **Trees and treatments: Time for some adjustments.** Tuin & Landschap. 17: 13-15; 1984.

Advancements in science take place as sound old information is connected with new information. The new connections lead to expansions of concepts. And from expanded concepts come new approaches to old problems. This is the normal path for improvements of all treatments. Trees and many treatments designed to help trees are reexamined in this paper.

Shigo, Alex L. **Wood problems start in the living tree.** Forest Notes. Fall (15): 20-22; 1984.

Long before the log reaches the mill, the quality of the wood is set, and little can be done to change it. Major attempts to utilize low-quality wood more effectively center about chipping, grinding, or reducing the wood to smaller pieces, and then putting the pieces back together to make some usable product. The steady increase in these techniques attests to the increasing amount of low-quality wood that must be used by industries. Indeed, the best utilization of low-quality material is an admirable venture. It must be done. But, when low-quality trees are replaced with more low-quality trees, this ceases to be forestry.

Shigo, A. L.; van der Zwet, T. **Patterns of barrier zone formation in *Pyrus* wood tissues infected with *Erwinia amylovora*.** Phytopathology. 74(7): 851; 1984. Abstract A491.

Longitudinal dissections of 30 fire blight cankers representing scores 1 to 9 on the USDA fire blight scoring system were collected from 100 6-year-old pear trees. Following bark removal from 25 stems, the internal cankers showed that patterns of blight-infected wood followed the CODIT model for compartmentalization of decay in trees. Most cankers were associated with branch crotches. When infected leader stems died, the boundary between living and dead tissues farther down on the stem usually occurred above a healthy lateral branch. Further spread of the infection below a healthy branch was limited to wood connected to the leader stem and not to the healthy branch.

Shortle, W. C. **Biochemical mechanisms of discoloration, decay, and compartmentalization of decay in trees.** IAWA Bulletin. 5(2): 100-104; 1984.

Lists, in chronological order, 100 papers by Shigo, Shortle, and their associates. Thirteen review papers from 1965 to 1984 recognize the contributions of many scientists and attempt to expand our thinking about how

res decay and how trees respond to limit the internal spread of decay. The 87 research papers cited, published from 1962 to 1983, form the foundation for ongoing research into biochemical mechanisms of discoloration, decay, and compartmentalization of decay in trees.

Smith, H. Clay. **Forest management guidelines for controlling wild grapevines.** Res. Pap. NE-548. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 15 p.

Grapevines are becoming a major problem to forest managers in the Appalachians, especially when clearcutting is done on highly productive hardwood sites. Where present, grapevines can reduce tree quality and growth, and eventually kill the tree. Silvicultural characteristics of grapevines are discussed as background for grapevine control. Forest management guidelines are given for controlling growth of grapevines.

Soderman, David L. **Quality response of even-aged 80-year-old white oak trees after thinning.** Res. Pap. NE-543. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, 1984. 6 p.

Stem defects were studied over an 18-year period to determine the effect of thinning intensity on quality development of 80-year-old white oak trees. Seventy-four white oak trees from a thinning study in Kentucky were analyzed from stereo photographs taken in 1960 and 1978. Stem-related defects were measured on the upper 8-foot and second 8-foot sections of each tree. The number of defects per square foot of surface area increased significantly at the heaviest thinning level. The data suggest that heavy thinning has a detrimental effect on potential stem quality.

Soderman, David L. **Quality response of 29-year-old, even-aged central hardwoods after thinning.** Res. Pap. NE-546. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 9 p.

Describes the quality response of a 29-year-old upland hardwood stand grown for 6 years under different levels of residual stand density. Both the number of defects per square foot of surface area and the number of epicormic branches changed under different stocking levels. The results suggest that the effect of stocking on potential stem quality of certain species may be substantial even after a few years of treatment.

Starkland, David N.; Sneckenberger, John E.; Biller, Cleveland J. **Loadings in a cable logging system in Appalachia.** In: Proceedings, 1983 winter meeting American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. Paper No. 83-1628. St. Joseph, MI: American Society of Agricultural Engineers; 1983. 11 p.

Results obtained from a mathematical model and the loading in a medium-sized European yarder are presented. These results are used to discuss strengths of selected components. Also, moments that might cause tipping are correlated with lateral and downhill yarding incidences.

Swift, Bryan L.; Larson, Joseph S.; DeGraaf, Richard M. **Relationship of breeding bird density and diversity to habitat variables in forested wetlands.** Wilson Bulletin. 96(1): 48-59; 1984.

Breeding bird populations were studied in eight deciduous forested wetlands located in the Connecticut Valley region of Massachusetts. Singing male birds were counted on 10 circular 0.25-ha plots in each study area in June 1978 and 1979. A total of 46 species was observed, with estimated densities varying among study areas from 134 to 720 males per 40 ha. Avian community parameters (total breeding bird density, bird species richness, and abundance of three foraging guilds) were related to 15 habitat variables by multiple regression and simple correlation.

Tattar, Terry A.; Shigo, Alex L. **Mower wounds kill trees.** Weeds Trees & Turf. 23(4): 36, 41; 1984.

Thompson, Ralph L.; Vogel, Willis G.; Taylor, David D. **Vegetation and flora of a coal surface-mined area in Laurel County, Kentucky.** Castanea. 49: 111-126; 1984.

A descriptive study was made in 1981 and 1982 of the vegetation and flora on an 18-year-old surface-mined area near Lily in Laurel County, Kentucky. More than 100 woody and herbaceous taxa were planted on about 25 percent of the area in 1965 and 1966. Some of the planted area and most of the unplanted area subsequently were revegetated by natural plant succession. The natural plant community was sampled by the belt transect and quadrat methods; the vascular flora was documented by field reconnaissance; and planted experimental plots were inventoried for surviving species. A Virginia pine-mixed hardwoods community was the major natural vegetation type. The vascular flora comprised 350 taxa from 84 families; 77 of these were non-indigenous taxa. Thirty-seven indigenous and 41 non-indigenous species have persisted from the original experimental plantings.

Tilghman, Nancy G. **Deer densities and forest regeneration.** In: Research in forest productivity, use, and pest control: Proceedings of the symposium; 1983 September 16-17; Burlington, VT. Gen. Tech. Rep. NE-90. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984: 45-50.

Preliminary results of a study of the effects of five deer densities and three cutting treatments on development of tree seedling reproduction on the Allegheny Plateau of northwestern Pennsylvania show that higher deer densities reduce the height growth made by seedlings in clearcut and thinned stands. Moreover, there are fewer tree seedling species, less *Rubus*, and more fern at higher deer densities.

Tilghman, Nancy G. **Deer browse and forest regeneration.** Pennsylvania Forests. 74(3): 6-8; 1984.

Preliminary results of a study of the effects of five deer densities and three cutting treatments on development of tree seedling reproduction on the Allegheny Plateau of northwestern Pennsylvania show that higher deer densities reduce the height growth made by seedlings in clearcut and thinned stands. Moreover, there

are fewer tree seedling species, less Rubus, and more fern at higher deer densities.

Tritton, L. M.; Siccama, T. G. **Population dynamics of dead trees in the Northeast.** Bulletin of the Ecological Society of America. 65(2): 249; 1984. Poster Session.

Tryon, E. H.; Powell, Douglas S. **Root characteristics of advance hardwood reproduction.** Forest Ecology and Management. 8: 293-298; 1984.

Advance reproduction is important in naturally regenerating stands of hardwood tree species. Well-established root systems are considered essential in assuring such regeneration. This paper reports results from four studies conducted in northern West Virginia that obtained data on the ages and diameters of roots of nine hardwood species. Samples were taken from understory trees with maximum diameters below the root collar of 5.08 cm. We found that ages ranged from 1 to 50 years and averaged 12.6; diameters ranged from 0.15 to 5.03 cm and averaged 0.76 cm. Indications are that root systems of advance reproduction may often exceed the 50 years of age documented.

Tubbs, Carl H. **Silviculture.** In: Wenger, Karl F., ed. Forestry Handbook. New York, NY: John Wiley & Sons; 1984: 414-455.

The purpose of the section is to provide a basis for the development of prescriptions for silvicultural procedures to meet multiple-use goals. General explanations of silvicultural systems and procedures are followed by specific examples. Descriptions of site preparation include a listing of herbicides, species affected, and method of application. Tree planting techniques are illustrated. The section includes a brief explanation of financial maturity.

Tubbs, Carl H.; Reid, Bruce D. **Logging season affects hardwood reproduction.** Northern Journal of Applied Forestry. 1(1): 5-7; 1984.

The Rochester District of the Green Mountain National Forest has kept records of regeneration following clearcut and shelterwood harvesting since 1969. Harvesting was in winter and summer. The records show that season of logging did not affect the number of stands with adequate stocking but that winter logging resulted in somewhat better stocking of sugar maple and yellow and paper birch. Shelterwoods were better stocked with sugar maple than clearcuts, which on average were better stocked with the birches. The year of cut seemed to have the greatest influence on the relative proportion of birches and sugar maple after clearcutting.

Valentine, Harry T.; Houston, David R. **Identifying mixed-oak stand susceptibility in gypsy moth defoliation: An update.** Forest Science. 30(1): 270-271; 1984.

Two discriminant functions for the identification of mixed-oak stand susceptibility to gypsy moth defoliation are presented. One function uses variables that reflect gypsy moth habitat; the other uses only standard inventory variables.

Valentine, Harry T.; Tritton, Louise M.; Furnival, George M. **Subsampling trees for biomass, volume or mineral content.** Forest Science. 30(3): 673-681; 1984.

A procedure for estimating aboveground biomass, woody volume, or mineral content of a tree uses randomized branch sampling and importance sampling, a technique of Monte Carlo integration. Both techniques involve sampling with selection probabilities proportional to estimated size and produce unbiased estimates of tree components and their variances. The results of a field test of the procedure for the estimation of fresh weight are presented.

Vodak, Mark C.; Wellman, J. Douglas. **Visual impacts are important to private landowners in managing eastern hardwoods.** National Woodlands. 7(3): 10-12; 1984.

Describes a study designed to measure esthetic consequences of any management practice in a stand. Objectives of the study were to: (1) quantitatively describe general landowner preferences for approaches and levels of hardwood management ranging from clearcut to unmanaged stands, (2) develop statistical models that use standard forest measurements to predict landowner preferences for the visual aspects of the site, and (3) make practical management recommendations and suggest further research initiatives based on these analyses.

Vogt, Albert R.; Redett, Robert B.; Foulger, Albert N.; Barnard, Joseph E. **Ohio's forests are growing.** Ohio Woodlands. 21(4): 4-5, 9; 1984.

Wallner, William E. **Gypsy moth ecology and management research.** In: Miller, A. D., ed. National gypsy moth review: Proceedings of a symposium; 1984 November 26-29; Charleston, WV. Charleston, WV: West Virginia Department of Agriculture Plan Pest Control Division; 1984: 89-91.

The major recent emphasis of the USDA Forest Service's Ecology and Management research unit is to elucidate the concept of gypsy moth outbreak foci. Historical evidence and recent research has demonstrated that stands susceptible to gypsy moth exist but their relationship to areawide outbreaks is not known. If they serve as epicenters from which outbreaks emanate, control can be initiated prior to outbreaks on a limited geographic area. This would change current control strategies and increase the options for management. At the very least, they can serve as predictors for population upsurges that would be useful for land managers, pest control personnel, and for development of Integrated Pest Management systems.

Wallner, William E.; Carde, Ring T.; Xu-Chonghua; Weseloh, Ronald M.; Xilin, Sun; Jingjun, Yan; Schaefer, Paul W. **Gypsy moth (*Lymantria dispar* L.) attraction to disparlure enantiomers and the olefin precursor in the People's Republic of China.** Journal of Chemical Ecology. 10(5): 753-757; 1984.

Pheromone traps baited with disparlure, cis-7,8-epoxy-2-methyl-octadecane, captured males of the gypsy moth, at two widely separated locations in the People's Republic of China. The (+) enantiomer of disparlure attracted significantly more males than the racemate;

addition of olefin reduced captures. The duration of the flight period was longer (8 weeks) and peaked earlier near Beijing than farther north near Dunhua (5 weeks).

Walters, Russell S. **Black cherry provenances for planting in northwestern Pennsylvania.** Res. Pap. NE-552. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 6 p.

After 14 years, survival of 8 of 25 planted black cherry sources is greater than 70 percent, and there are no significant differences in height. These sources offer the greater potential for planting in northwestern Pennsylvania; they include four Pennsylvania sources plus one each from Tennessee, West Virginia, Ohio, and Virginia. Planted trees did not grow better than nearby natural seedlings.

Walters, Russell S.; Yawney, Harry W. **Treat your maple trees well.** New England Farmer. 8(3): 12-15; 1984.

Ward, Richard E.; Leslie, A. Cameron; Biller, Cleveland J.; Peters, Penn A. **Field studies and analysis of a feller-buncher operation.** In: Proceedings, Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 229-242.

Describes field studies and the subsequent analysis of production data of a Feller-Buncher unit. The studies were conducted in conjunction with the harvesting of two different hardwood stands. Time standards and cost estimates are presented.

Wargo, Philip M. **After the gypsy moth: What you can expect.** In: Proceedings, Tree wardens, arborists, and utilities conference; 1984 March 13-15; Danvers, MA. Amherst, MA: Cooperative Extension Service, University of Massachusetts; 1984: 87-94.

What you should expect after the gypsy moth has defoliated your forests and disappeared depends on how much foliage was eaten, the number of successive years of defoliation, growing conditions, the physiological condition of the tree when it was defoliated, and the presence of aggressiveness of pathogens and insects.

Wargo, Philip M. **Changes in phenols effected by *Armillaria mellea* in bark tissue of roots of oak, *Quercus* spp.** In: Kile, G. A., ed. Proceedings, 6th international conference on root and butt rots of forest trees; 1983 August 25-31; Melbourne, Victoria, and Gympie, Queensland, Australia. IUFRO S2.06.01. Melbourne, Australia: CSIRO; 1984: 198-206.

The effect of *A. mellea* on phenols in bark tissue of roots of oaks was determined in vivo by analyzing bark tissues from roots of black oak and white oak that were defoliated by insects and naturally colonized by the fungus. Results indicate that *A. mellea* (sensu lato) can oxidize and grow in the presence of oxidized phenols but only on weakened tissues.

Wargo, Philip M. **How stress predisposes trees to attack by *Armillaria mellea*—a hypothesis.** In: Kile, G. A., ed. Proceedings, 6th international conference on root and butt rots of forest trees; 1983

August 25-31; Melbourne, Victoria, and Gympie, Queensland, Australia. IUFRO S2.06.01.

Melbourne, Australia: CSIRO; 1984: 115-121.

Stress predisposes trees to infection by *Armillaria mellea*. Stresses such as drought, waterlogging, and defoliation induce changes in root physiology and chemistry that are beneficial to the fungus. The nature of these changes and their interaction with the fungus are described and discussed. A hypothesis on how roots are predisposed to infection by *A. mellea* is presented.

Weik, Bruce R.; Wengert, Eugene M.; Schroeder, James; Brisbin, Robert. **Practical drying techniques for yellow-poplar S-D-R flitches.** Forest Products Journal. 34(7/8): 39-44; 1984.

The objectives of this study are to determine: (1) the duration of predrying heat or steam treatment needed to relax growth stresses adequately in yellow-poplar S-D-R flitches, (2) the effect of these predrying treatments followed by solar- and air-drying on grade losses in yellow-poplar S-D-R studs, and (3) the cost of applying successful predrying treatment and drying methods as compared to the cost of high-temperature drying in the S-D-R process.

Wendel, George W.; Kochenderfer, James N. **Aerial release of Norway spruce.** Northern Journal of Applied Forestry. 1(2): 29-32; 1984.

Restrictions on use of 2,4,5-T have created a need for herbicides that can be used for conifer release. Seven-year-old Norway spruce was released from competing vegetation with aerially applied Roundup. A wide spectrum of competing species was controlled and most hardwoods did not resprout during the 2-year evaluation period following treatment. Norway spruce seemed to respond to treatment and suffered negligible damage. Roundup as applied in this study seems to be a safe, effective herbicide that can be used to release Norway spruce.

Wharton, Eric H. **Identifying aboveground wood fiber potentials in New York State.** Resour. Bull. NE-82. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 25 p.

A statistical analytical report on the biomass resources of New York. The study was conducted in conjunction with the third forest survey of New York by the USDA Forest Service. Statistical findings are based on new 10-point variable radius plots, a canvass of wood manufacturers, timber utilization plots, and a mail canvass of private, commercial, forest-land owners; all conducted in 1978 and 1979. Presents total aboveground biomass supplies, the use of biomass in the state for forest products, and sources of wood from residues and standing trees that can be used to improve wood fiber recovery.

Wharton, Eric H. **Predicting diameter at breast height from stump diameters for northeastern tree species.** Res. Note NE-322. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.

Presents equations to predict diameter at breast height from stump diameter measurements for 17 northeastern tree species. Simple linear regression was used to

develop the equations. Application of the equations is discussed.

Wharton, Eric H.; Raile, Gerhard K. **Biomass statistics for the Northern United States.** Res. Note NE-318. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 3 p.

The USDA Forest Service now estimates biomass during periodic resource inventories. Such biomass estimates quantify more of the forest resource than do traditional volume inventories that concentrate on tree boles. More than 48 percent of the aboveground tree biomass in the northern United States can be found in woody material outside of the boles. Tree biomass in the Northeastern and North Central regions of the United States is compared by state.

Wharton, Eric H.; Brooks, Robert T. **Southern New England's forest resources inventory.** Connecticut Woodlands. 48(4): 6-7, 15; 1984.

During 1984, the Forest Inventory and Analysis staff will conduct an inventory of the Forest Resources of Connecticut, Massachusetts, and Rhode Island. Although many of the traditional measures of timber will be used, this new inventory will include more multi-resource information. Biomass, wildlife habitat, and recreational potentials will be reported on once the forest resource inventory is completed.

Wiant, Harry V., Jr.; Knight, Robert; Baumgras, John E. **Relation of biomass to basal area and site index on an Appalachian watershed.** Res. Note NE-315. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.

The biomass of 50-year-old cove hardwood and upland oak stands on an Appalachian watershed was more strongly related to basal area than the site index. Equations are presented for predicting the green and dry weight per acre of biomass components with basal area as the independent variable.

Widmann, Richard H.; Blyth, James E. **Pulpwood production in the Northeast and North Central States in 1982.** Northern Logger. 32(8): 10-11; 1984.

Twenty-one Northeastern and North Central states produced a total of 14.3 million cords of pulpwood in 1982. This total was the same as 1981, but its components showed a shift from residues to roundwood.

Wilson, G. Edward; White, David E.; Biller, Cleveland J. **The influence of site factors on production cost predictions for the Appalachian thinner.** In: Proceedings, Mountain logging symposium; 1984 June 5-7; Morgantown, WV. Morgantown, WV: West Virginia University; 1984: 323-335.

Small cable yarding systems have great potential for logging small tracts in mountainous terrain. One such yarding system is the Appalachian thinner. This paper describes an economic model designed to predict harvesting cost based on the capabilities of the Appalachian Thinner and the characteristics of the site. Actual and predicted harvesting costs are compared in order to evaluate the model.

Wisniewski, M.; Bogle, A. L.; Shortle, W. C.; Wilson, C. L. **Interaction between *Cytospora leucostoma* and host-phenolic compounds in dormant peach trees.** Journal of American Society of Horticultural Science. 109(4): 563-566; 1984.

The interaction between *Cytospora leucostoma* (causal agent of peach canker) and host-phenolic compounds in dormant peach trees was examined. Initially, inoculated samples had significantly higher phenolic levels than uninoculated samples. The levels in inoculated samples decreased dramatically in tissues closest to the point of inoculation, however, while the phenolic levels in uninoculated samples remained relatively stable through time. The data suggested that *C. leucostoma* degraded host-phenolic compounds. Maximum phenolic enrichment was observed in the branch collar region of the main stem of inoculated samples. It was concluded that the presence of *C. leucostoma* in host tissue played a significant role, over and above the wounding response, in establishing levels of host-phenolic compounds. Levels of phenolics in host tissue seemed to increase in advance of the fungus, and this increase may function as a mechanism that slows the pathogen's advance.

Yaussy, Daniel A.; Sonderman, David L. **Multivariate regression model for partitioning tree volume of white oak into round-product classes.** Res. Note NE-317. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 4 p.

A plant to make standard blanks from cants by System 6 can be assembled from off-the-shelf equipment with few modifications. From the production rates and manpower requirements of each piece of equipment, we designed a typical plant and determined by economic analysis that it could return 21 percent on an investment of \$2 million by making blanks for sale from purchased cants.

Yawney, Harry W. **How to root and overwinter sugar maple cuttings.** American Nurseryman. 160(8): 95-102; 1984.

Procedures are presented for the rooting and overwintering of sugar maple cuttings. Rooting can vary from 0 to 100 percent depending upon the rooting potential of a given genotype, and a period of trial-and-error will establish which genotypes are good rooters. The major obstacle to a successful propagation program has been overwintering failure of the rooted cuttings. The methods presented have resulted in overwintering survival rates approaching 100 percent. This is achieved by forcing the newly rooted cutting to flush and produce new foliage prior to overwintering by applying gibberellic acid (7500 ppm) to the terminal bud daily for a period of 2 weeks.

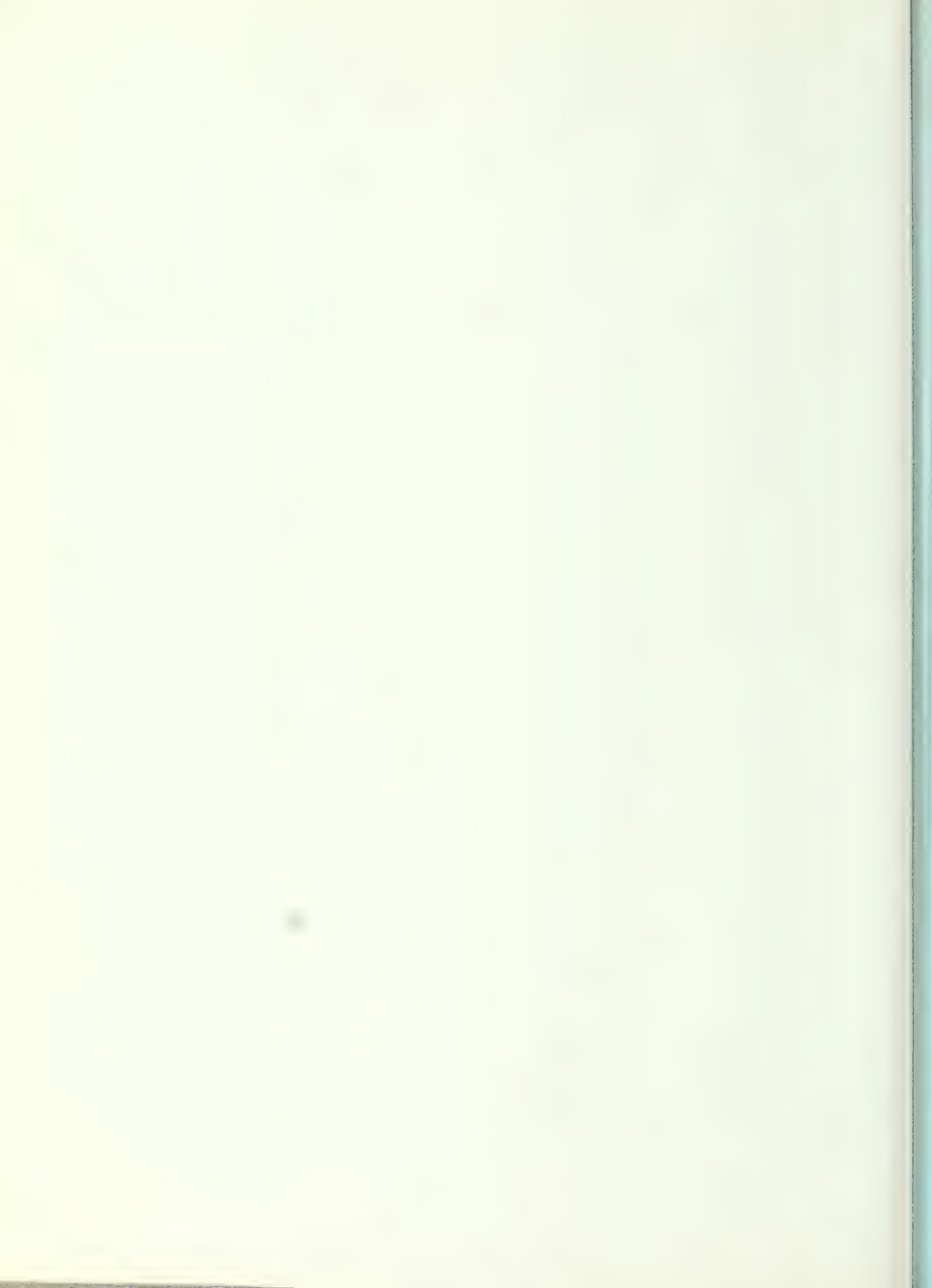
Zinn, Gary W.; Miller, Gary W. **Increment contracts: Southern experience and potential use in the Appalachians.** Journal of Forestry. 82(12): 747-749; 1984.

Increment contracts are long-term timber management contracts in which landowners receive regular payments based on the average annual growth of wood their land is capable of producing. Increment contracts have been used on nearly 500,000 acres of private forests in the

South. Southern experience suggests that several changes in the contract would improve its utility: the contract period should be shortened, the percentage of annual growth used to determine payments to landowners should be reduced, and payments should be based on published stumpage or product price reports. With these changes, there would be opportunities for, and benefits of, using increment contracts in the central Appalachians. In the near future, increment contracts may be used in parts of the Appalachians where competition for stumpage is keen.

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Northeastern Forest Experiment Station. **Publications of the
Northeastern Forest Experiment Station—1984.** Gen. Tech. Rep.
NE-110. Broomall, PA: U.S. Department of Agriculture, Forest
Service, Northeastern Forest Experiment Station; 1986. 29 p.

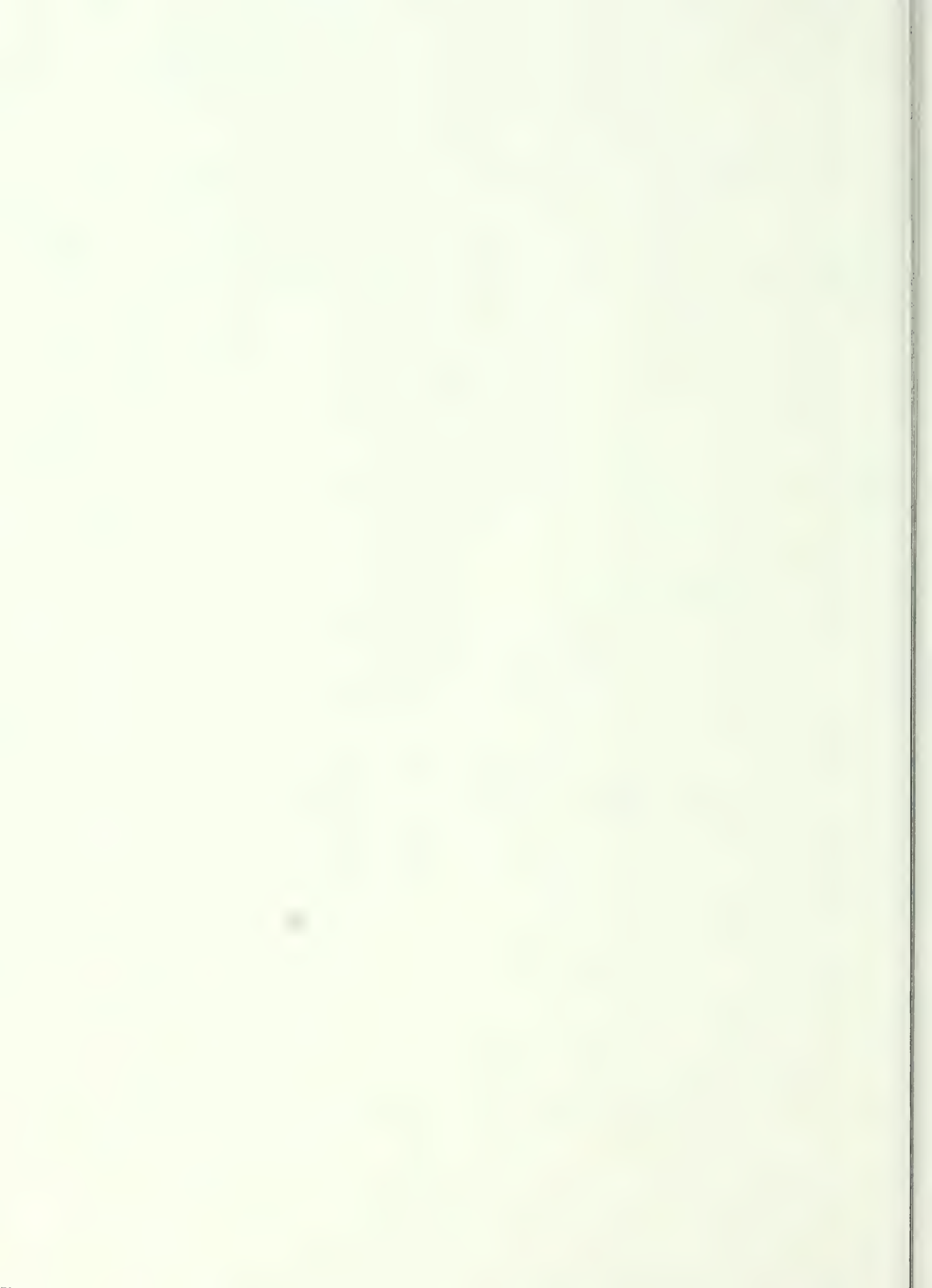
An annotated list of publications by Northeastern Forest Experiment
Station scientists in 1984.

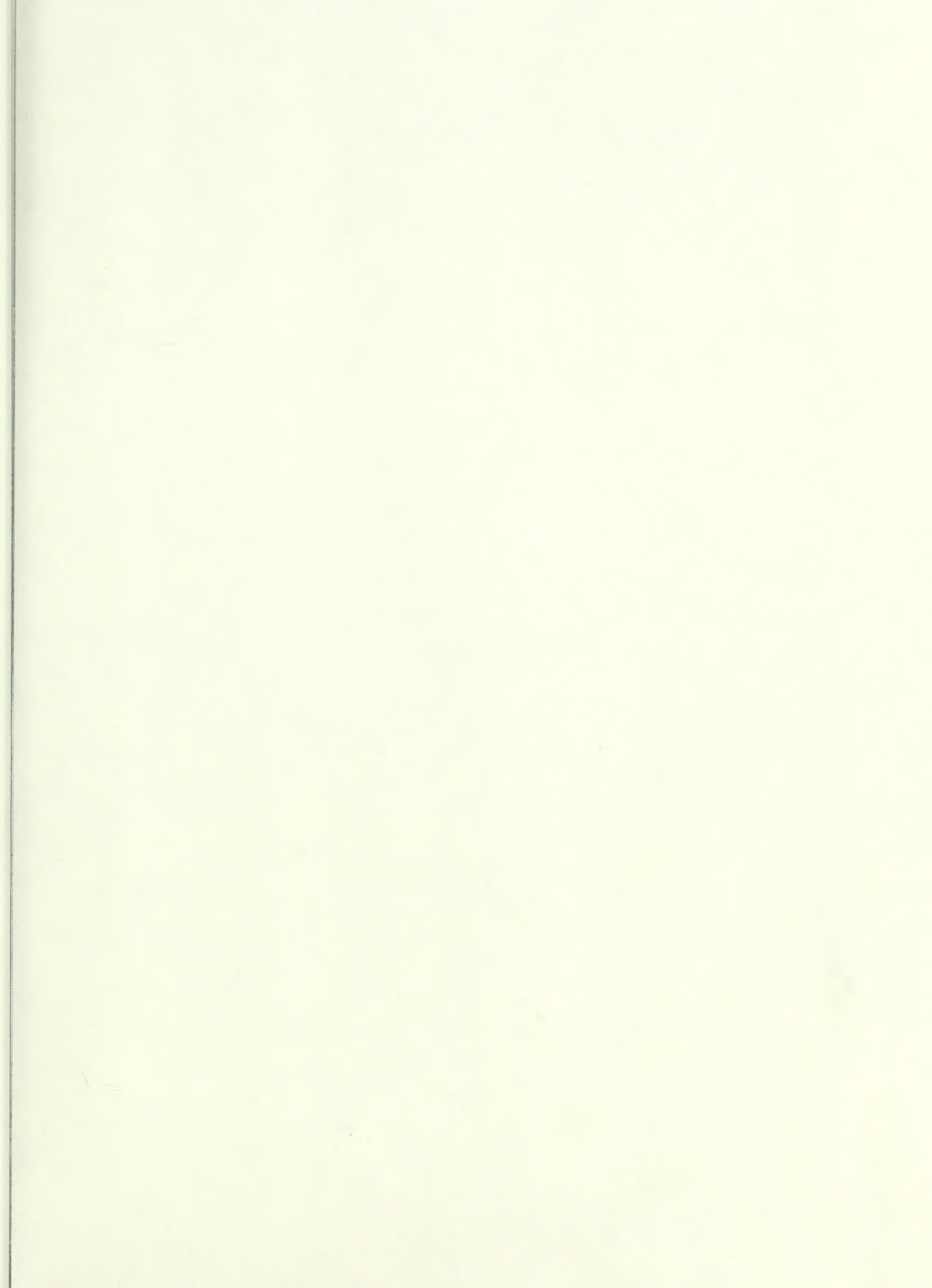
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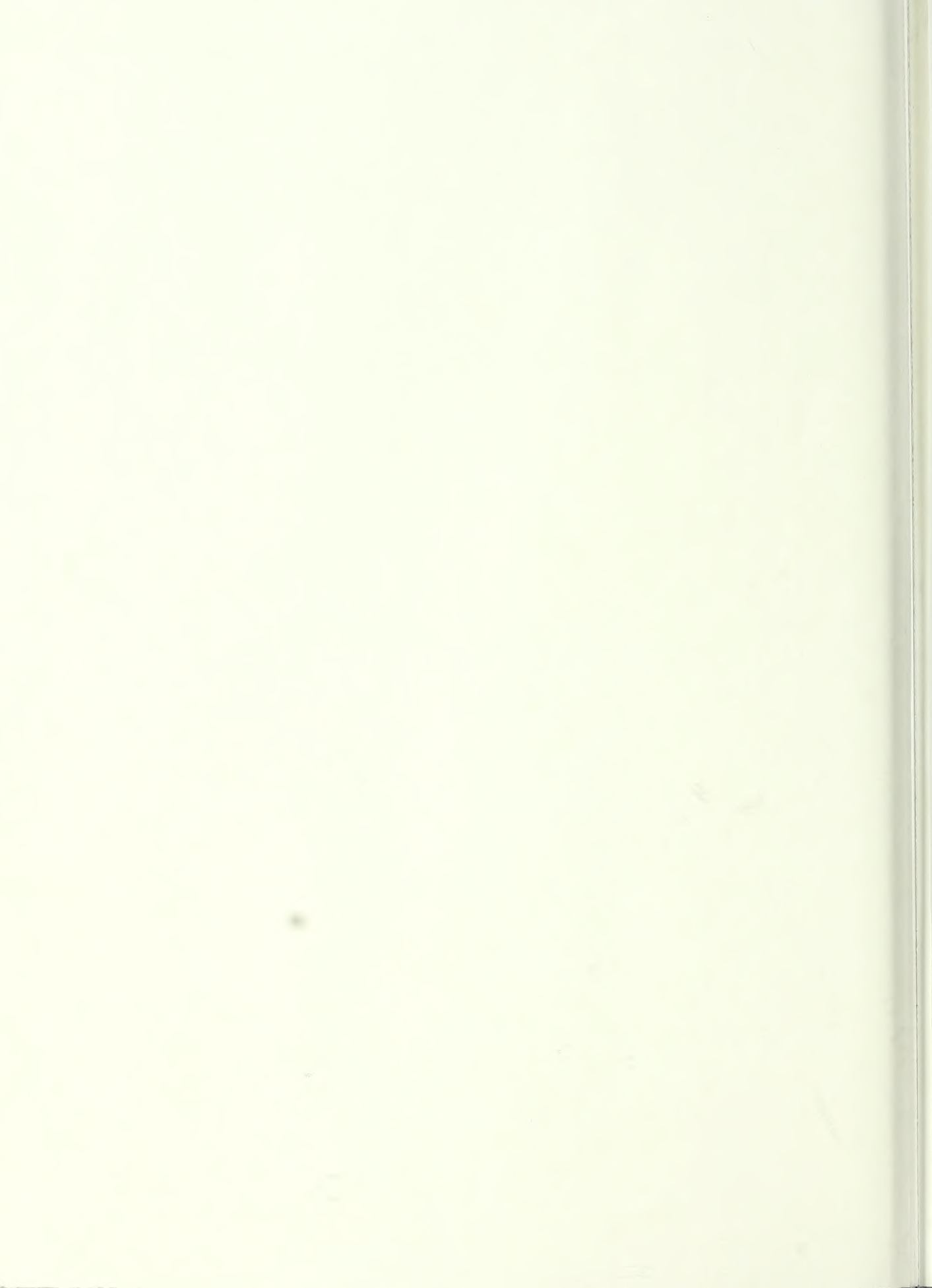
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Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
 - Berea, Kentucky, in cooperation with Berea College.
 - Burlington, Vermont, in cooperation with the University of Vermont.
 - Delaware, Ohio.
 - Durham, New Hampshire, in cooperation with the University of New Hampshire.
 - Hamden, Connecticut, in cooperation with Yale University.
 - Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
 - Orono, Maine, in cooperation with the University of Maine, Orono.
 - Parsons, West Virginia.
 - Princeton, West Virginia.
 - Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
 - University Park, Pennsylvania, in cooperation with the Pennsylvania State University.
 - Warren, Pennsylvania.
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